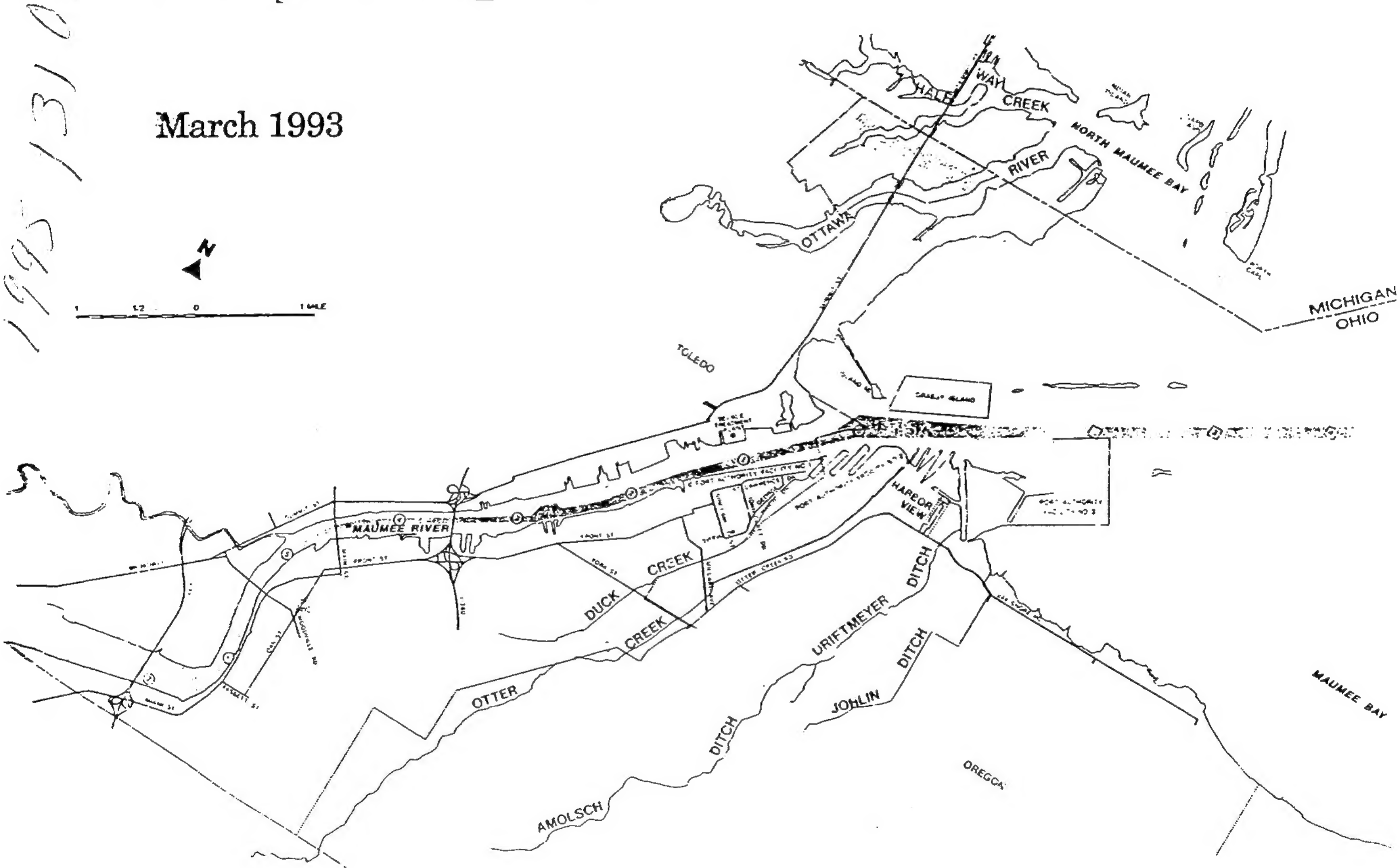
Long-Term Dredged Material Management Plan
within the context of
Maumee River Watershed Sediment Management Strategy

Toledo Harbor, OH

Phase 1 Report

March 1993



Planning Group:

U.S. Army Corps of Engineers
U.S. Soil Conservation Service
U. S. Environmental Protection Agency
U.S. Fish and Wildlife Service
Michigan Dept. of Natural Resources
City of Toledo
Ohio Dept. of Natural Resources
Ohio Environmental Protection Agency
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This technical report draws several preliminary conclusions about the investigations needed to develop specific management options. It recommends moving ahead to the Phase 2 Study to address these options that would meet the goals of sediment load reduction, improvement in sediment and water quality, beneficial uses of the material, and a reduced dependency on construction of new Confined Disposal Facilities (CDF).

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PREFACE

The work described in this report was performed by the Toledo Harbor Planning Group, an inter-governmental agency group created by a directive from the Assistant Secretary of the Army for Civil Works. The Group is working under the chairmanship of the U.S. Army Corps of Engineers, Buffalo District. Within the context of the development of a sediment management strategy for the Maumee River, the Group stated goals were to promote long-term dredged material management strategies to keep the Port and Harbor open and safe to navigation; and to explore and promote productive use of dredged material as a resource.

This Phase 1 report describes the project location, scope and authorization, dredging requirements, existing disposal site capacities, material characteristics, volume reduction, and environmental resources and concerns. It also identifies and recommends for further studies potentially viable concepts for :

- the development of **Intermediate or Transition Plan(s)** leading to

- the development of long-term dredged material management **Action Plan(s)** by October 1993.

The following individuals, on behalf of the agencies they represented in the inter-governmental Study Team, largely contributed to the development of this report:

Mr. Robert Burris - Civil Engineer, US Soil Conservation Service(USSCS)
Mr. Jeff Busch - Limnologist, Ohio Lake Erie Office
Mr. Wiener Cadet - Civil Engineer, US Army Corps of Engineers (USACE)
Ms. Colleen Crook - Civil Engineer, Ohio Envir. Protection Agency (OEPA)
Mr. Bill Franz - Environ Engineer, US Envir Protection Agency (USEPA)
Mr. Hall Harrington - Biologist, Michigan Department of Natural Resources (MDNR)
Mr. Kent Kroonemeyer - Biologist, US Fish and Wildlife Service (USFWS)
Ms. Julie Letterhos - Environmental Specialist, Ohio Environmental Protection Agency (OEPA)
Mr. John Loftus - Seaport Director, Toledo-Lucas County Port Authority
Mr. John Rupert - Biologist, Ohio Department of Natural Resources (ODNR)
Mr. Whit Van Cott - Civil Engineer, City of Toledo
Ms. Holly Wirick, Environmental Specialist, US Environmental Protection Agency (USEPA)

Numerous other technical staff members from the participating agencies, private citizens and groups have greatly contributed to this study and preparation of this report.

Mr. Thomas Bender, Civil Engineer, USACE
Mr. Don Borkowski, Civil Engineer, USACE
Mr. Len Bryniarski, Ecologist, USACE
Dr. Jeff Burnham, Consultant, N-Viro
Mr. Bernie Czartoski, Coordinator, MVRC&D
Mr. Steve Davis, Agronomist, USSCS
Ms. Judy Flint, Geo-hydrologist, USACE
Mr. Norman Francingues, Envir. Engr, USACE
Mr. John Hull, Civil Engineer, Hull & Assoc.
Mr. Thomas Kovacik, Consultant, N-Viro
Dr. Dick Lee, Soil Scientist, USACE
Mr. Mike Mohr, Civil Engineer, USACE
Mr. Gary Overmier, Esquire, USSCS
Dr. Mike Palermo, Civ. Engr. USACE
Mr. Stan W. Perry, Consultant, S&L Fert.
Mr. Scott Pickard, Biologist, USACE
Mr. Tom Pieczynski, Hydr. Engr. USACE
Mr. John Skogerboe, Phys Scient, USACE
Mr. James Wade, Geologist, USSCS

This Phase I study was conducted under the direct supervision of the Executive Committee of the Planning Group chaired by the Corps of Engineers, Buffalo District Commander, Colonel John W. Morris. Other members of the Executive Committee were:

Mr. Valdas Adamkus, Regional Administrator, U.S.EPA
Mr. Joseph Branco, State Conservationist, U.S.SCS
Ms. Frances Buchholzer, Director ODNR
Mr. Gary Failor, President, Toledo Lucas County Port Authority
Mr. Thomas Hoover, Manager, City of Toledo
Mr. Donald Schregardus, Chairman, Ohio EPA

EXECUTIVE SUMMARY

The Toledo Harbor Planning Group, made up of Federal, State and local agencies, is tasked to address the problem of managing sediment dredged from the Toledo Harbor River and Lake Approach Channels. In April 1992, the Assistant Secretary of the Army for Civil Works directed that this group be formed to work together as partners in the development of an Action Plan. A Work Plan, developed in May 1992 to lay out the studies and schedule, was signed by all the partner agencies. The Group expanded the scope of the study to include management of sediment throughout the Maumee River Watershed. This action by the Group requires investigation to develop a long-term sediment management strategy (LTMS) for the Basin.

This Phase 1 Report is the first compilation of the literature and field data collected, reviewed and summarized as well as the initial formulation of the problem and potential solutions leading to the Action Plan. The success of the Planning Group to date is measured by the progress made as expressed by this report, as well as, the commitment and cooperative team spirit of the partners. This group continues to progress towards the Action Plan which is scheduled for submission and approval in October 1993.

This report sets the stage for the formulation of alternative management options to be performed in Phase 2 study by: defining the problem; establishing the study geographic limits and time frame; reviewing historical dredging quantities and dredged material management actions; reviewing sediment characteristics and quality; presenting environmental concerns related to dredging and disposal; listing management options identified to date; and proposing several preliminary concept plans. The report also presents some preliminary screening of management options.

The No-Action plan discussed in this report presents the direction dredged material management is expected to take in the near term, and the potential for reduction in the level of maintenance dredging and preclusion of its use as a commercial harbor. The capacity of the existing disposal facilities could be depleted in a few years and without a LTMS the future maintenance of the Harbor could be stymied. This in turn could lead to real economic losses for the water-dependent and associated industries using the Harbor.

This Phase 1 Report draws several preliminary conclusions about the investigations needed to develop specific management options. It recommends moving ahead to the Phase 2 Study to address these options that would meet the goals of sediment load reduction, improvement in sediment and water quality, beneficial uses of the material, and a reduced dependency on construction of new Confined Disposal Facility (CDF). The report also cites the need for: the development of environmental, engineering and economic criteria for evaluating the alternative management options (Phase 2) with a view to developing and recommending an Action Plan (Phase 3) for detailed studies and implementation (Phase 4).

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I. INTRODUCTION

The Port of Toledo, Ohio is a bustling domestic and international shipping center, stretching along the banks of the Maumee River, the largest river flowing into the Great Lakes. Ocean and Lake vessels have docked at the Port of Toledo since 1837. Today, the Port *(Figure 1)* has nearly 20 companies along the Maumee River that accept cargo from these vessels; but it has been the versatility of the port that has identified most of its success over the years. Cargo includes coal, grain, iron ore, petroleum products, and various general cargoes. Ferrous and non-ferrous metals have had strong movements through the Port since the 1930's. The Port of Toledo handled 96 percent of all U.S. Great Lakes deliveries of zinc in 1989; and with the port selection last year as the warehouse for the London Metals Exchange, non-ferrous imports are expected to increase substantially in future years. In 1992, over 12 millions tons of cargo came into the Port of Toledo, a 5 percent increase over 1991. Port operations are responsible for 5,000 jobs and had a monetary impact of over half a billion dollars. Because of the availability of land, Toledo is a possible coal-blending site, which brightens the long-range viability for the Port. With continued economic growth as seen in 1992, the Port will maintain and expand its role as a great asset to the Northwest Ohio area and will be valuable for decades to come. Toledo has the 5th largest harbor on the Great Lakes and the 37th largest in the United States. The 1992 economic evaluation performed by the Corps of Engineers, Buffalo District indicated that the harbor generates a magnitude of short-term benefits several times that of annual maintenance costs. Its potential for brightening the long-range scenario continues to appear promising. Nevertheless, the Harbor's long-term economic viability must be addressed within the context of the development of long-term sediment management strategies for Maumee River.

Toledo's location at the hub of a major North American market has made it a key player in Midwestern commerce, and within the past three decades since the opening of the Saint Lawrence Seaway, a factor in global commerce as well. By creating the necessary programs to expand the harbor's capabilities, increased growth of the Port of Toledo is inevitable.

Due to the shallowness of Lake Erie and the Maumee River, large sediment load from Maumee River, and vessel traffic, dredging of the Toledo Harbor River and Lake Approach Channels remains necessary. These channels are an essential corridor for the flow of goods and the economic well-being of the area.

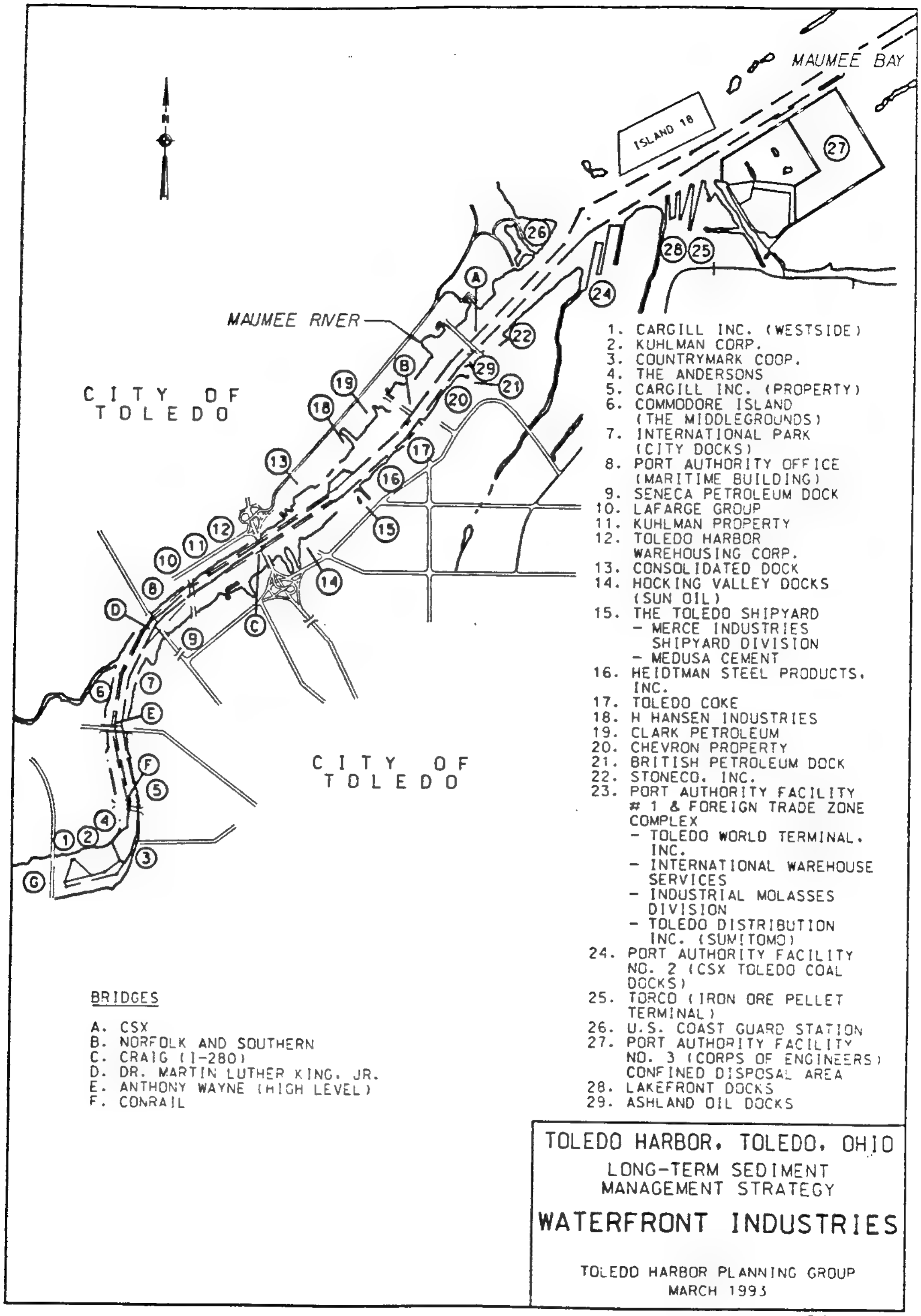


Figure 1 - Waterfront Industries

The dredging operations performed by the Corps of Engineers have been a recurring process since the late 1800's. The Port of Toledo has had to progressively address the ever changing needs of incoming vessels. Increased dependency on waterborne trade in bulk and general cargo will increase the need for dredging the Port of Toledo. The first appropriation for the improvement of Toledo by the United States Government was made by the River and Harbor Act of June 13, 1866. By successive Acts, the channel depth was increased from a depth of 15 feet in 1875 to a depth of 25 feet in 1936. The straight 17 mile long and 500 feet wide channel in Maumee Bay was completed in 1892. In 1960 the River and Lake channels were deepened to 27 and 28 feet respectively. The primary factors influencing the maintenance of these channels had been cost and environmental considerations. Since the early 1960's however, as environmental concerns of open lake disposal became known, the disposal of dredged material in the open waters of Western Lake Erie presented potential water quality impacts. In the late 1960's and early 1970's when contamination of bottom sediment and degradation of water quality in the lower Maumee River were identified, the City of Toledo and the State of Ohio cooperated with the Federal Government to provide facilities for the confinement of the harbor dredged material. The City of Toledo, the Toledo-Lucas County Port Authority, and the State of Ohio acted early and developed a plan that, when implemented, resulted in significant improvements in both the sediments and water quality. The Federal Government enacted laws on the disposal of dredged material. Section 123 of the 1970 River and Flood Control Act (Public Law 91-611) authorized the Corps of Engineers to construct, operate and maintain contained disposal areas for polluted dredged material in the Great Lakes area. This law provided for the construction of Confined Disposal Facilities (CDF) at no cost to local interests other than supplying lands, easements and rights of way and without justification beyond water pollution control. As a result, the existing 240-acre Confined Disposal Facility was constructed in 1976 to contain the more heavily contaminated dredged material from Toledo Harbor navigation channels.

Up to 1976, the preponderance of dredged material at Toledo Harbor was disposed of in the open waters of the Western Basin of Lake Erie with some discharged into Confined Disposal Facilities along the banks of the Maumee River, and in Island 18. From 1976 to 1984, all dredged material from Toledo Harbor was confined in a CDF because of elevated contaminant levels. In the later part of this 1976-84 period, because of significant improvement in the pollution abatement effort by the State, the Corps of Engineers requested and obtained from the U.S. Environmental Protection Agency a reclassification of sediment in the Lake Approach Channel, from Lake Mile 2 to Lake Mile 16, as being suitable for open-lake disposal.

Beginning in 1985 through 1991, all dredged material lakeward of Lake Mile 2 has been placed at designated open-lake disposal sites in the Western Basin. All materials dredged from Lake Mile 2 up to River Mile 6 have been placed in the existing 240-acre CDF.

Since 1985 there have been a number of concerns expressed by various agencies, individuals and groups regarding open-lake disposal. Environmental concerns included potential adverse impact on Lake Erie water quality: resuspension and movement of materials from the disposal site, possible impact on water quality at the Toledo water treatment plant, phosphorus input to Lake Erie and eutrophication (algal growth), lake sediment chemistry and biota, and use of near-shore areas for the construction of dredged material Confined Disposal Facilities.

In an effort to satisfactorily address these environmental concerns, the U.S. Army Corps of Engineers, the Ohio Environmental Protection Agency, the Toledo Metropolitan Area Council of Government, the Toledo-Lucas County Port Authority and the City of Toledo signed a five-year Memorandum of Agreement (MOA) in 1986 "to explore a mechanism for the maintenance of Toledo Harbor and the protection of the quality of the water in Lake Erie". The MOA was also designed to build a framework for cooperative investigation of alternatives to open-lake disposal which was scheduled to be phased out in 1991. Beneficial use/reuse of sediment dredged from Toledo Harbor navigation channels was to be pursued.

In 1992, the Assistant Secretary of the Army for Civil Works, Ms. Nancy Dorn, directed the Corps of Engineers to develop, by October 1993, a jointly supportable long-term dredged material management **Action Plan** for Toledo Harbor, through the identification of Long-Term Dredged Material Management Strategies (LTMS). Elements of the plan were to include an evaluation of the relative costs of confined disposal versus open water disposal. The Secretary's directive resulted in the creation of the aforementioned Planning Group of several local, state and Federal agencies that agreed to work together to develop the mutually acceptable plan called for by the Secretary's office.

To date, the Planning Group has identified several alternative sediment management options, including environmental restoration, beneficial uses of dredged material, ultimate recycling of Confined Disposal Facilities, use of CDF in tandem, aquatic disposal, and sediment load reduction. All potentially viable measures will be thoroughly analyzed and assessed through a five-phase study approach. The first three phases will identify and recommend for implementation alternative plans having potential to address the problem of managing dredged material at Toledo Harbor within the context of the Maumee River watershed sediment management strategy.

The five phases of this approach for developing and implementing the LTMS are:

Phase 1. Evaluate Existing Management Options
Phase 2. Formulate Alternatives
Phase 3. Preliminary Analysis of Alternatives
Phase 4. Implementation (including detailed design) of Recommended Alternatives
Phase 5. Periodic Review and Update

Detailed descriptions of these phases are presented in the July 1992 Work Plan developed by the Planning Group, and appended to this report *(Appendix F)*.

The Planning Group was committed to investigate these and other appropriate measures, and to develop and implement alternative plans by achieving the following specific goals:

* Continue to keep Toledo's Port and Harbor open and safe for navigation;

* Promote dredged material management options that restore and/or enhance the environment, and have inherent acceptability and value to all partners of the Planning Group; and

* Explore and promote productive use of dredged material as a resource through an effective Public Involvement Program which increases citizens' awareness, interest and cooperation.

The specific purpose of this Phase 1 report is to document a synopsis of existing management options and data for long-term dredged material management for Toledo Harbor within the context of the Maumee River watershed sediment management strategy. This synopsis includes a review of dredging volumes and frequencies, brief descriptions of dredging and disposal operations, existing disposal site capacities, and environmental resources and management options currently available. As discussed earlier, this Phase 1 report also identifies and recommends for further studies potentially viable concepts for the development of intermediate and long-term dredged material management Action Plan(s). The intermediate plan considers at least the next five years whereas the long-term plan will address the next fifty years.

II. PROJECT DESCRIPTION

(Affected Environment)

Toledo Harbor, located on the south shore of Lake Erie, is approximately 100 miles west of Cleveland, Ohio and 60 miles south of Detroit, Michigan. The Harbor is at the southwestern corner of Lake Erie where the Maumee River flows into Maumee Bay. The Maumee River forms at Fort Wayne, Indiana, at the confluence of the Saint Mary's and Saint Joseph's Rivers, and flows approximately 130 miles before entering Lake Erie at Toledo, Ohio. The River is the largest tributary to the Great lakes; it has a 6,750-square mile watershed *(Figure 2)* and an average discharge of about 4,800 cubic feet per second.

Maumee Bay, a wide inlet of Western Lake Erie along the south shore, extends lakeward to two spits - North Cape which extends south from Michigan, and Little Cedar Point which extends northwest from Ohio. The Maumee River, Ottawa River and several small creeks enter the shallow bay on the west. Water circulation within the Bay is influenced by the Detroit and Maumee River flows, the Toledo Edison Power Plant, Lake Erie currents, and wind and physical irregularities in the bay shoreline and bottom.

The existing Federal navigation project *(Figure 3)* provides for:

A. An 18-mile long navigation channel, 28 feet deep and 500 feet wide from deep water in Lake Erie to the mouth of the Maumee River, including a widening of 38.6 acres opposite Chesapeake and Ohio Railway and Lakefront Terminal docks;

B. A navigation channel in the river which varies in widths from 200 to 400 feet, and in depths from 25 to 27 feet. The channel is 27 feet deep and 400 feet wide from the river mouth (mile 0) to river mile 3; thence 400 feet wide and 27 feet deep to river mile 6.5, and 200 feet wide, 25 feet deep to the upper limit of the project at river mile 7;

C. A turning basin opposite the American Ship Building docks (river mile 2.7), 750 feet wide, 800 feet long and 20 feet deep;

D. A turning basin just upstream from the Old Fassett Street Bridge (River mile 6.5), semi-circular in shape with radius of 730 feet, and 27 feet deep;

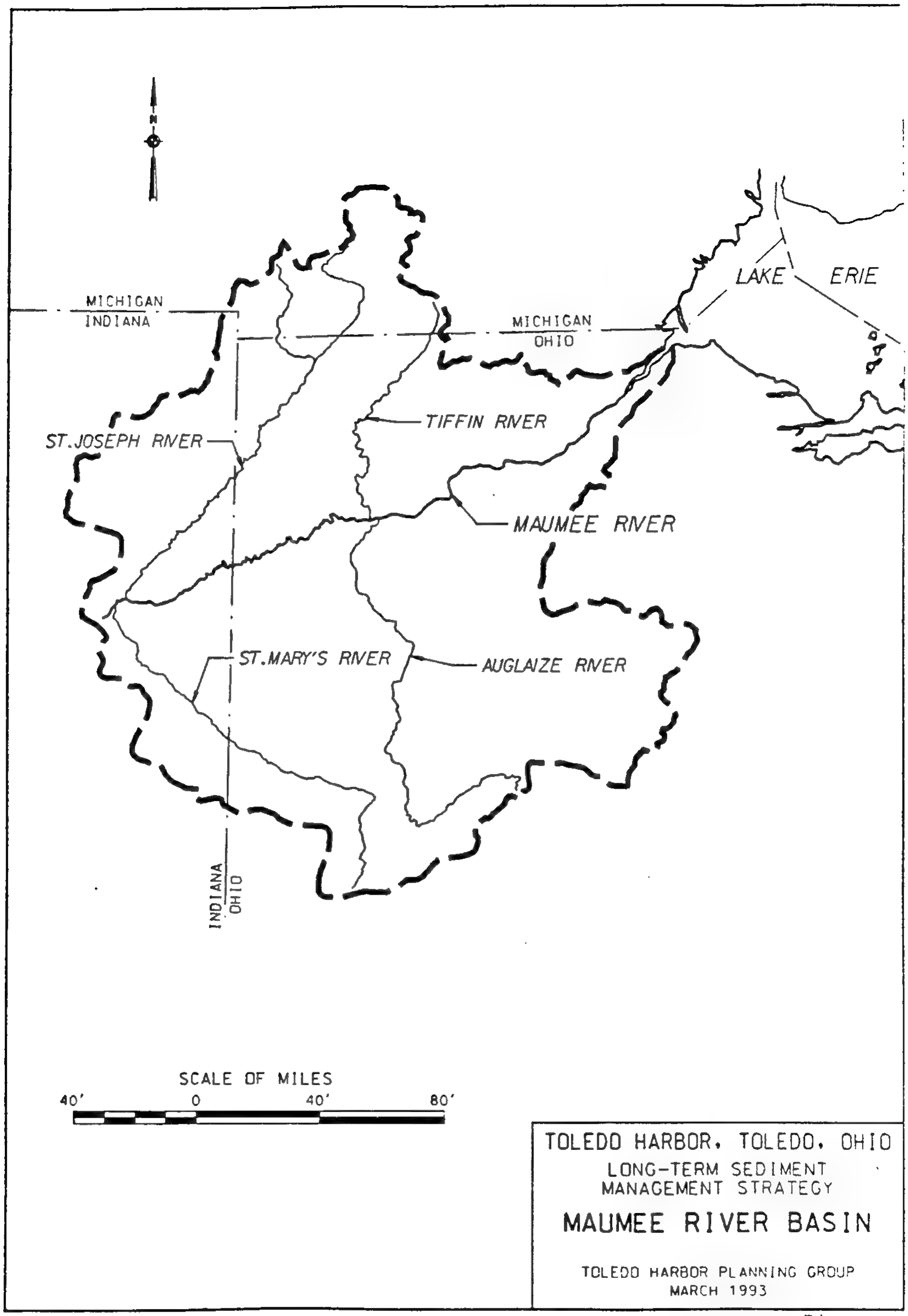


Figure 2 - Maumee River Basin

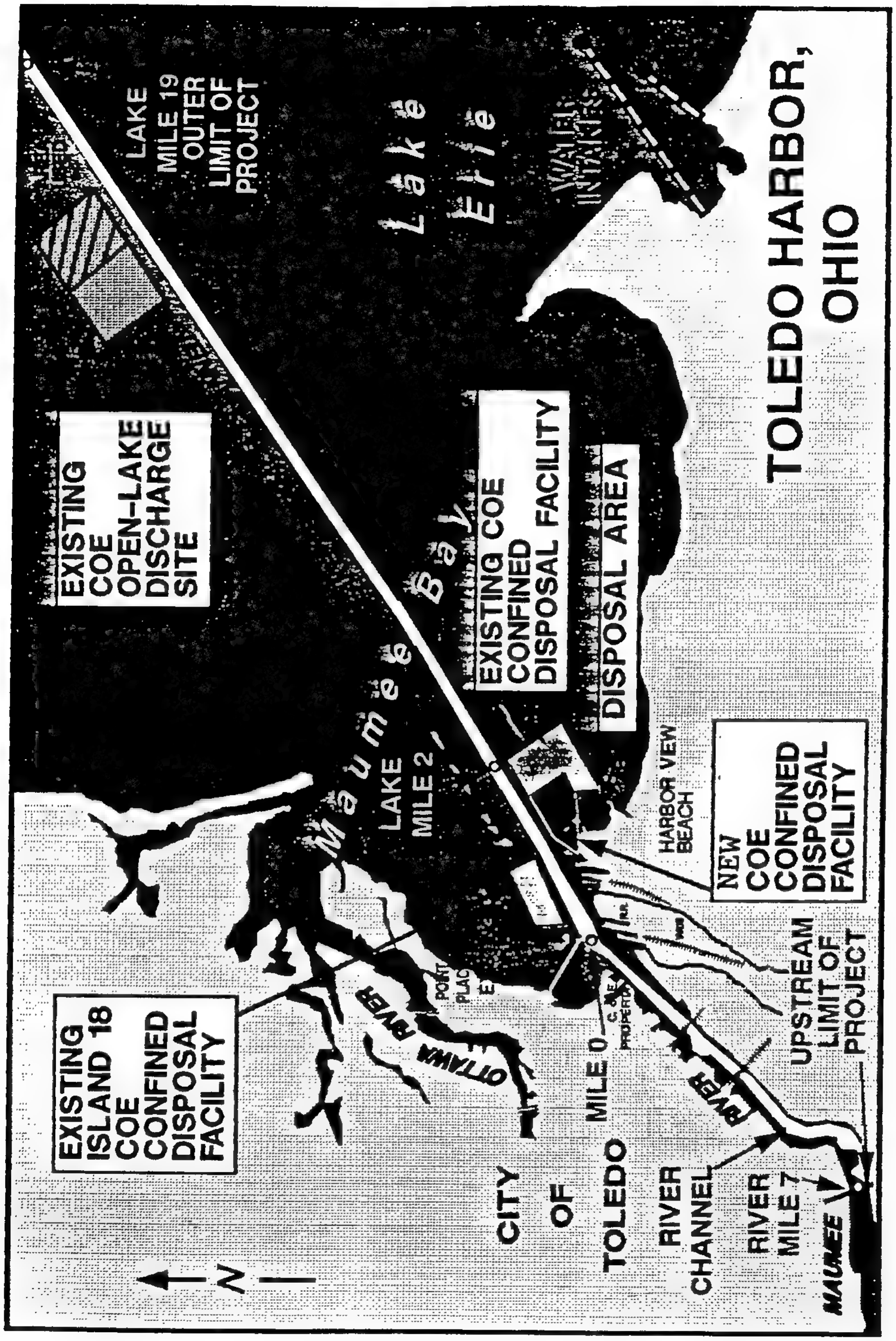


Figure 3 - Toledo Harbor, OH

E. An 8.25-acre turning basin, 18 feet deep, in the upper project limit; and

F. A clearing and sailing course between Maumee Bay Channel, and East Outer Channel, which leads to the Detroit River Entrance Channel, 28 feet deep and 1,200 feet wide.

The area served by Toledo Harbor includes the cities of Toledo and Oregon, and adjacent communities. The Toledo metropolitan area has a population of approximately 700,000 people.

The study area under consideration for the development of the long-term sediment management strategy extends beyond the limit of the existing Federal navigation project to the boundaries of the Maumee River Watershed. The watershed drains an area of about 4.2 million acres (USDA, 1993) from the States of Michigan, Indiana, and Ohio. The watershed is relatively flat and consists primarily of farmlands: 3.3 million acres of cropland, 50,000 acres of pasture, 100,000 acres of farmsteads, and 300,000 acres of forest land, which results in the river carrying a high sediment load. The basin is shaped like a round saucer with flat lake plains in the low center, sloping till plains around the higher periphery, and beach ridges scattered in between. Its soils are predominantly nearly level to gentle sloping. Streams of the Maumee River system are mostly of flat gradient. Average slopes for the Maumee, Saint Mary's and Saint Joseph's Rivers vary from 1.3 to 2.8 feet per mile. The soils in the basin are very poorly drained, moderately fine to fine textured, and formed in lacustrine and till material.

As a result of a number of historical issues raised over the years regarding the disposal of dredged material and its impacts on the environment, the Office of the Assistant Secretary of the Army by letter dated 23 April 1992 directed the Buffalo District Commander to convene a Planning Group to develop a long-term dredged material management plan for Toledo Harbor. The Long-Term Dredged Material Study was conducted under Code of Federal Regulations for navigation and navigable waters (Part 200 to end), revised July 1, 1991, or 33 CFR 337.9 that authorizes the Corps to identify and develop dredged material disposal management strategies for long-term needs, and to implement the National Environmental Policy Act, 33 CFR 233 and 40 CFR 1501.7, to determine the scope and significance of issues related to a proposed action.

Specifically, 33 CFR 337.9 states: "District Engineers should identify and develop dredged material disposal management strategies that satisfy the long-term needs for corps projects. Full consideration should be given to all practical alternatives including upland, open water, beach nourishment, within banks disposal, ocean disposal, etc. Within the existing policy, District Engineers should also explore beneficial uses of dredged material such as marsh establishment and dewatering techniques, in order to extend the useful life of existing disposal areas."

The Planning Group also had additional authorities from the other State and Federal agencies involved in the study. Further authorities were provided by the Water Resources Development Act of 1992, which directed development of a comprehensive sediment management strategy for Maumee River.

Further, Section 356(a and b) of the Water Resources Development Act (WRDA) of 1992 provided additional authority by directing the Secretary of the Army to coordinate with the Toledo-Lucas County Port Authority and the Ohio Environmental Protection Agency to develop comprehensive, short, and long-term sediment management strategies for the Maumee River; and authorized the Secretary to conduct the engineering and construction activities necessary to implement the short-term sediment management strategy developed pursuant to subsection(a).

III. PROBLEM IDENTIFICATION
(Problem/Needs/Opportunities)

This portion of the report describes the quantity of dredged material, and frequency and method of dredging, as well as the location, physical and chemical characteristics of the dredged material within the limits of the authorized Federal navigation channels and the existing dredged material open-lake discharge sites and CDFs at Toledo Harbor. It identifies the resources available for managing the dredged material in light of the upcoming dredged material inland testing manual. It also provides a broad overview of past studies and the biotic resources that may be affected by dredging or disposal operations.

A. WATERSHED EROSION/SEDIMENT LOAD REDUCTION

Because of the nearly impassable "Black Swamp" that covered the central and lower part of the Maumee River Basin, the early European settlers settled on land along the streams and creeks. At the time of their arrival during the Civil War, no methods of draining the Basin swamps were developed. From open ditches and wooden drains to clay, concrete and plastic lines, more and more acreage was cleared, drained, and opened to the process of accelerated erosion and sedimentation. Small grain and hay rotations were used to control weeds and pests on small fields. These relatively small fields and long rotations contributed to the Basin land erosion until after World War II.

The mechanical and chemical technology developed during the war years was adapted by the farmers. By the late 1960's and early 1970's, the use of agricultural chemicals led the farm operators to concentrate on a row crop rotation which accelerated the rate of soil erosion. Precipitation in the form of rain, melting snow drains the eroded soil off the farmland into the streams.

1. Watershed Erosion

Watershed erosion by water consists of sheet and rill erosion, gully erosion, and streambank erosion. Estimates of sheet and rill erosion show that since 1955 approximately 10.2 million tons of soil eroded in the Maumee River Basin on an average annual basis. Streambank and gully erosion were estimated at 100,000 tons per year. Total average annual watershed erosion since 1955 to date would average about 10.3 million tons (See USSCS Appendix C for details).

2. Transport of Eroded Material

Only a portion of the soil that is eroded within a basin is transported to the

mouth of the basin (USDA,SCS 1993). Some soil remains in the upland fields or is trapped in the floodplains, channels, lakes, and ponds. The USGS Gauge on the Maumee River at Waterville, Ohio, has measured an average annual suspended sediment load of 1,300,000 tons. Since 1951, this load represents most of the sediment that enters the Toledo Harbor River Channel, but is only 12 percent of the 10,300,000 tons of soil that has eroded within the basin annually. This percentage is termed a delivery rate or delivery ratio. A sediment rating curve and a sediment discharge ratio A/B graph have been developed for discharge and sediment load data from the Waterville USGS Gauge. *Figures 4 and 5* illustrate the linear relationship between sediment load and water discharge. *(USDA, SCS 1993, Appendix C)*.

3. Fluvial Sedimentation Dynamics in Toledo Harbor

Approximately 1.3 million tons of sediment annually passes the USGS stream gauge at Waterville, Ohio. A portion of this material is deposited in the ship channel each year. The U.S. Army Corps of Engineers dredges an average of 850,000 cubic yards of sediment from the ship channel annually. Available data on in situ sediments in the Maumee Basin indicate average densities of approximately 40 pounds per cubic foot (USDA,SCS 1990). At this density, the dredged mass would average approximately 421,000 tons annually, or 33 percent of the sediment that passes the Waterville Stream Gauge. The value of 33 percent is the average sediment trap efficiency of the River Channel. This value was also evaluated by empirical methods using sediment type, River channel capacity, and average annual water volume discharged into the channel. These calculations indicate a trap efficiency of 32 percent (USDA,SCS).

B. PREVIOUS DREDGING AND DISPOSAL OPERATIONS

Information on previous dredging and disposal operations was obtained from the Buffalo District Construction-Operations Division's records. The amount and detail of information available was varied, with the most information accessible for the immediate past.

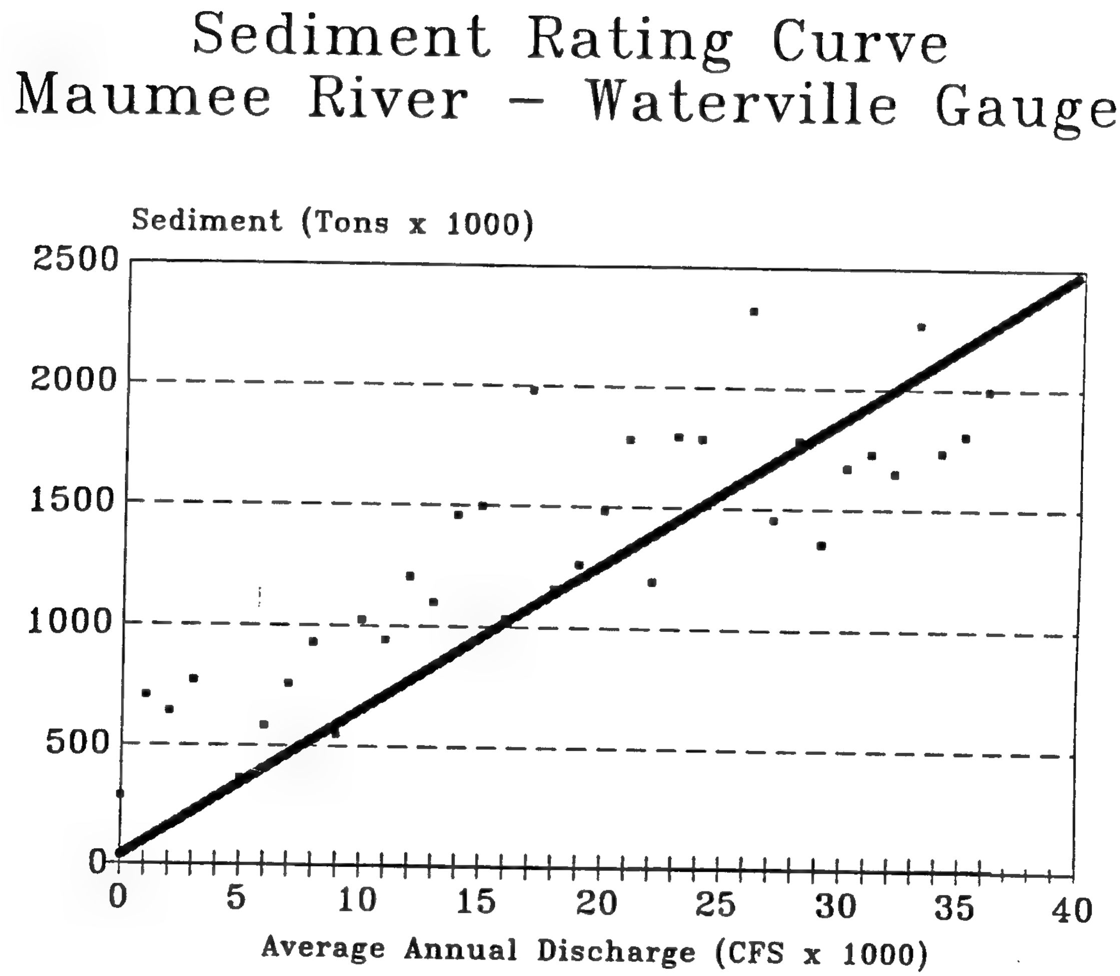


Figure 4 - Sediment Rating Curve

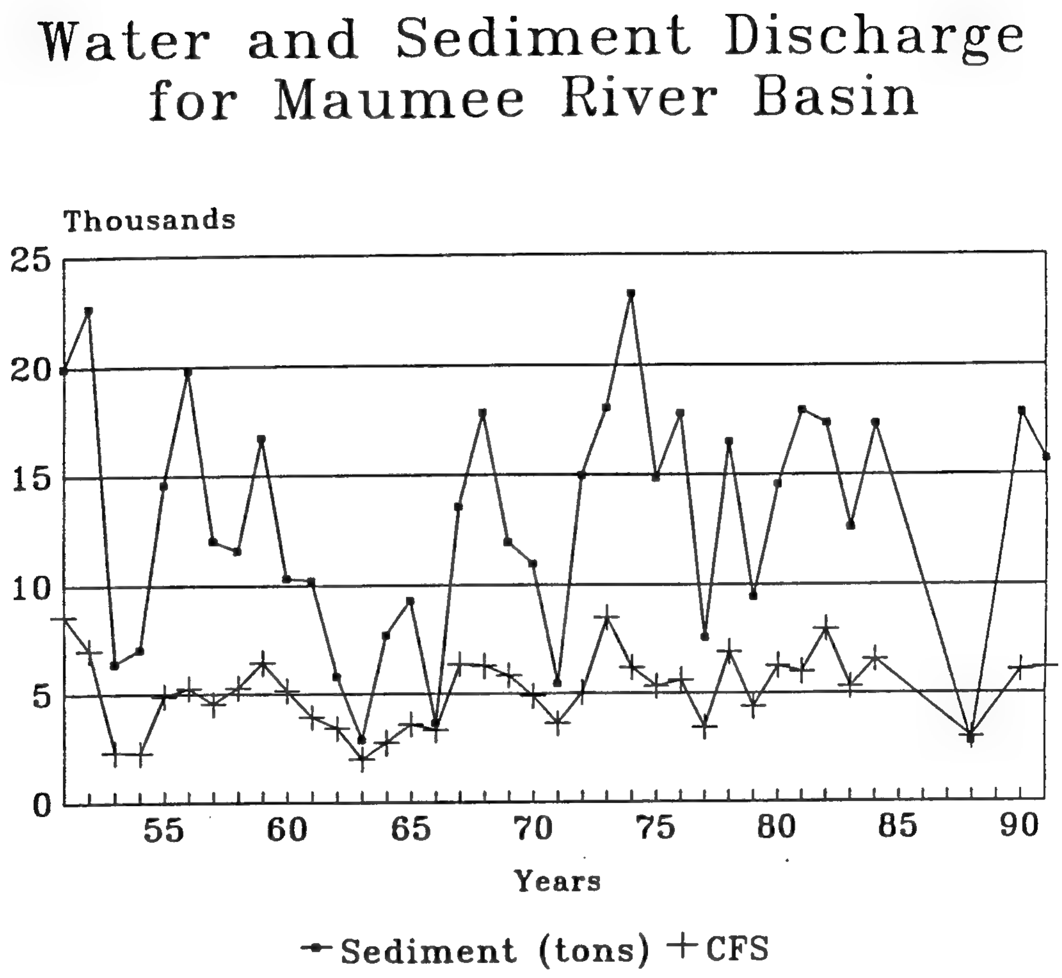


Figure 5 - Water and Sediment Discharge

The Toledo Harbor Channels are conceptually partitioned into two parts, the River Channel and the Lake Approach Channel. The upstream end of the River Channel is located at the turning basin immediately downstream of the SR80 bridge at about river mile 7 and extends downstream to the Maumee River mouth at river mile 0 (which equals lake mile 0) at station 400+00 *(Figure 6)*. The channel is generally 400 feet wide and is dredged to -28 ft LWD. The Lake Approach Channel is generally 500 feet wide, is dredged to -29 ft LWD and continues in a general direction of N58E. *Figure 6* presents a general map of the harbor with river/lake mile and station locations indicated.

General dredging operations data were available from 1978 to 1992 and are presented in *Table A1, Appendix A* . Prior to 1984, most of the dredging was accomplished by Corps of Engineers' owned and operated dredges. As the Corps dredges were phased out, dredging was accomplished by privately-owned and operated dredges under contract to the Corps of Engineers. All material was placed in the Confined Disposal Facility from 1976 to 1985. Between 1985 and 1991, material dredged upstream of lake mile 2 was placed in the Confined Disposal Facility with the remainder disposed in the open-lake. In 1992, all material dredged upstream of lake mile 5 was placed in the confined disposal facility with the remainder disposed in the open-lake.

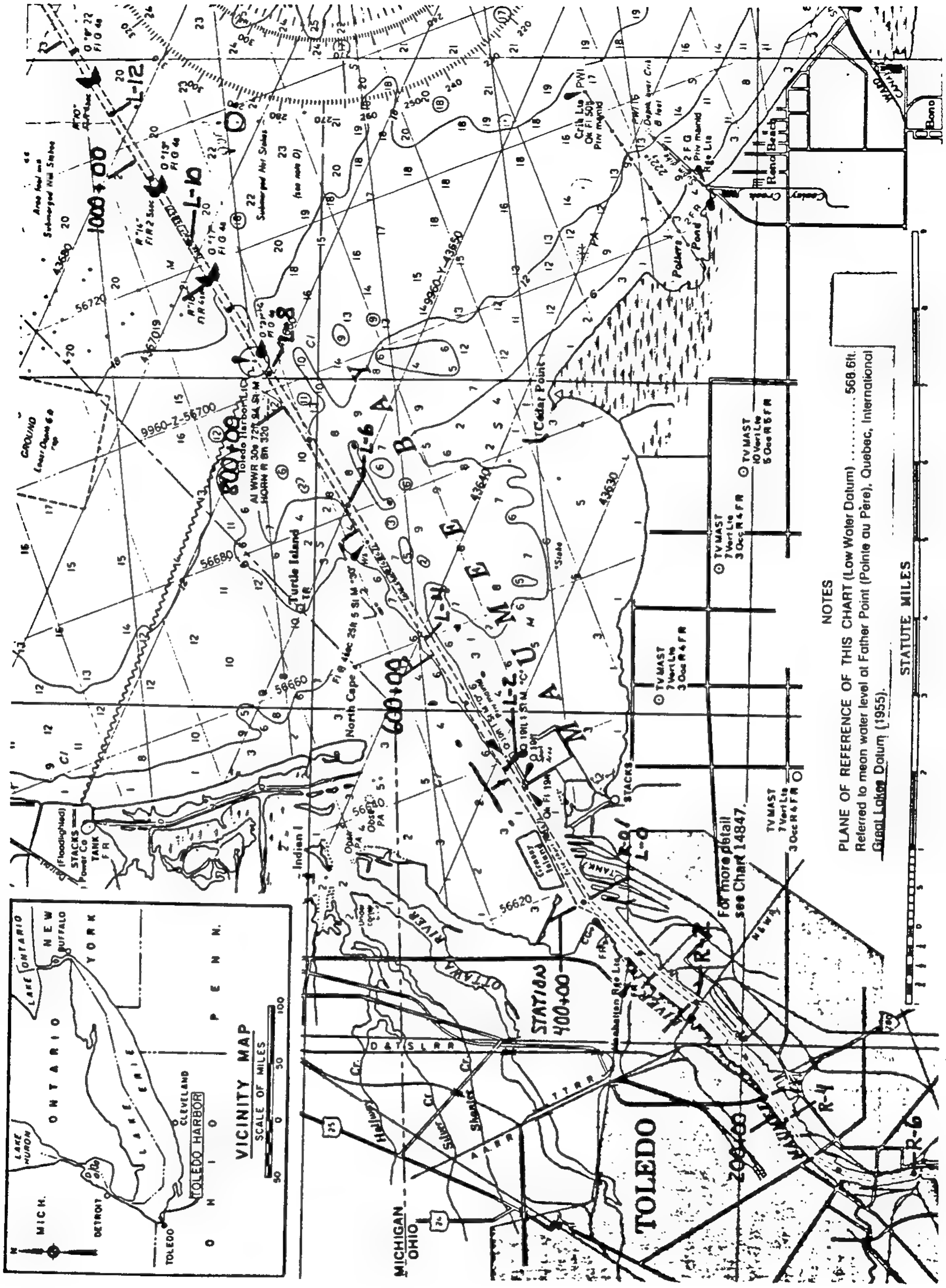


Figure 6 - Map of Toledo Harbor

The total quantity dredged annually from 1978 to 1992 ranged from 277,000 cubic yards (1978) to 1,198,000 cubic yards (1982) with an average annual total dredging quantity of 850,000 cubic yards. During the period 1985 to 1991, when all dredged material lakeward of lake mile 2 was disposed of in the open-lake, it was observed that a greater quantity of the material was disposed of in the open-lake. Hence more shoaling was occurring lakeward of lake mile 2. Analysis of dredging records has also revealed that from the period 1986 to 1992, dredging was generally required between river mile 1 and lake mile 7. Dredging is required sporadically in the upper river or further out in the Lake Approach Channel, which is due to a reduced shoaling rate in the outer reaches of the lake channel. Also, the numerous bridges spanning the river have caused an increase in dredge cycle time. *Figure 7* is a graphical presentation of the total dredging quantity by year and *Figure 8* is a similar presentation but also segments the data by location of disposal (confined or open-lake). *Figure 9* presents the general dredging location for the period 1986 to 1992.

Dredging information along the channels for 1992 *(Table A2, Appendix A)* was reviewed with the intent to establish the general shoaling pattern for that year. Channel cross-sections were obtained at 100 foot intervals "before" and "after" dredging. The before and after channel cross-sectional area, compared to the required section (pay prism), is partitioned into the amount of material in the channel (shoal), allowable overdepth (ovdpth) and the material within the channel sideslopes (slope). The difference of the total of these quantities before and after performing the dredging results in the quantity dredged. The average depth of shoaling in the channel is the net area dredged divided by the channel bottom width.

The average shoaling depth along the channel in 1992 is presented in *Figure 10.* The average shoaling depth in the river and lakeward to lake mile 3 was generally between 0.5 to 1 foot. After lake mile 3, the average shoaling depth increased to over 2 feet and decreased steadily from lake mile 5.5 to 7. *Figure 11* presents the cumulative dredging volume with channel location. Consistent with the increased shoaling lakeward of lake mile 3, the slope of the graph increases at this location and is uniform through this section. Three distinct regions of dredging are observed. Between approximately river miles 1 and 0, the required dredging along the channel was 11.9 cubic yards per foot. Between about lake miles 1.5 to 3, the required dredging was 12.4 cubic yards per foot. This value increased to 40.3 cubic yards per foot after lake mile 3 and steadily declined from lake mile 5.5 to 7. From *Figure 10 and Figure 11* it is surmised that the increased shoaling in the channel reach lakeward of lake mile 3 is due primarily to wave driven lake bottom sediment transport into the navigation channel. Dredging lakeward of lake mile 6 is generally less as the lake bottom becomes deeper and horizontal water particle velocities at the bed decrease.

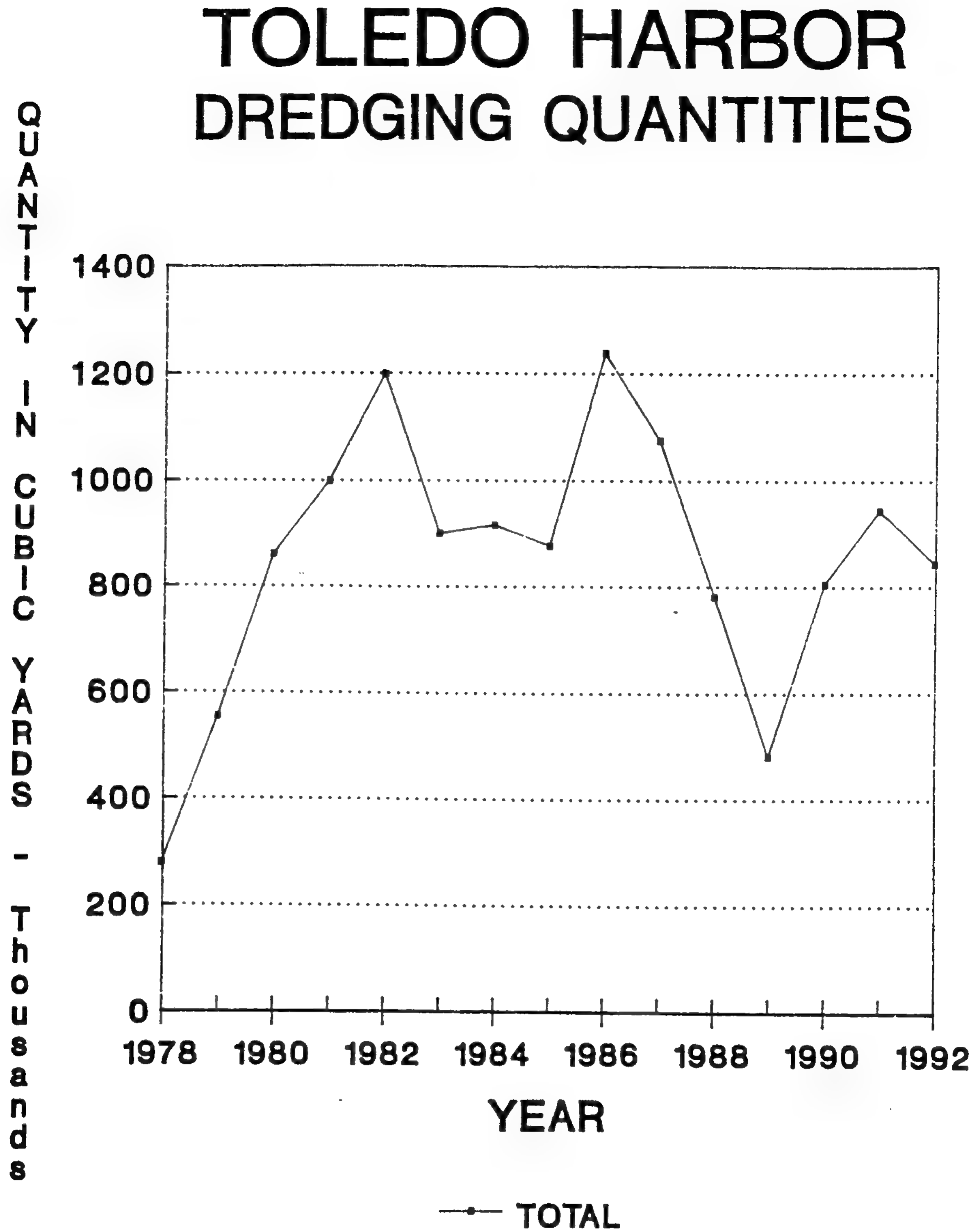


Figure 7 - Toledo Harbor Dredging Quantities

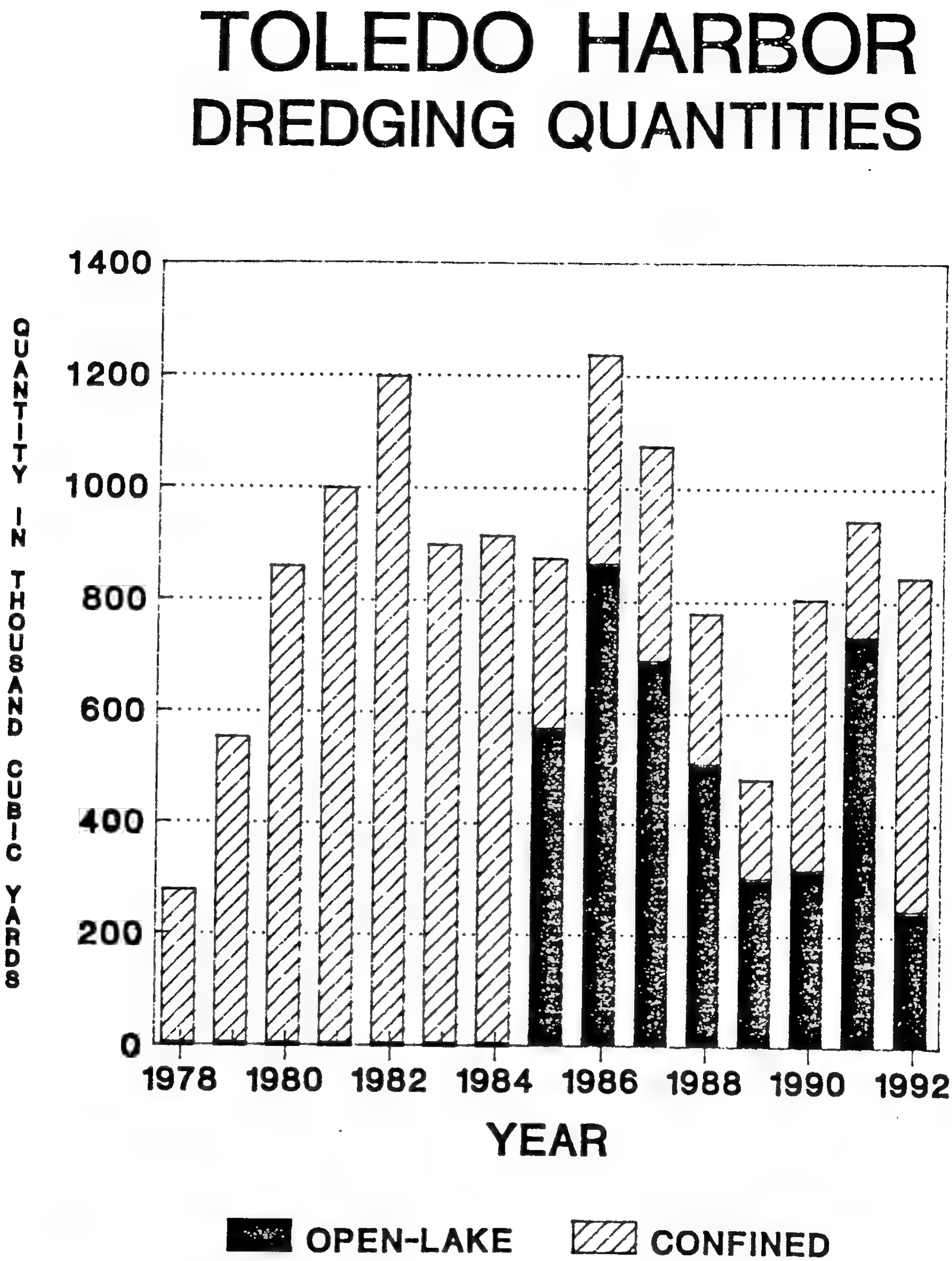


Figure 8 - Toledo Harbor Dredging Quantities

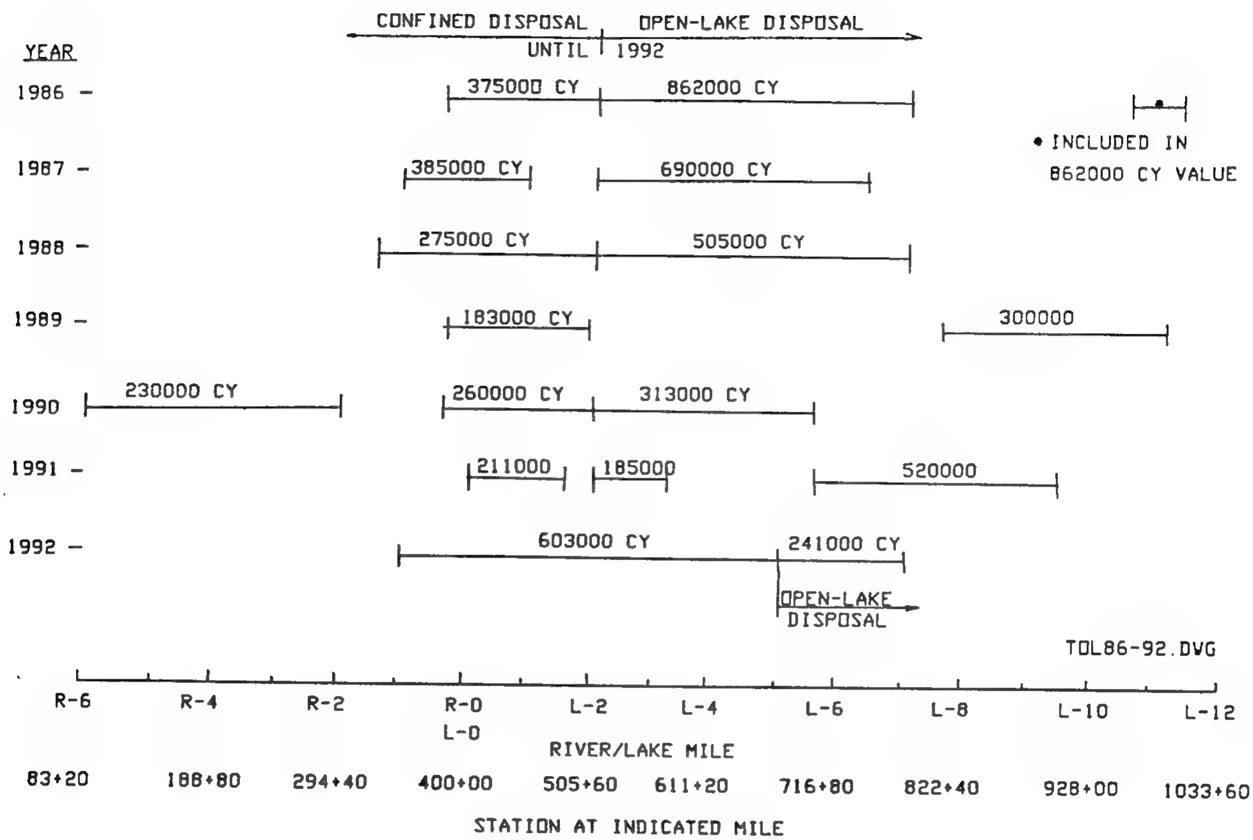


Figure 9 - *Dredged Material Quantities and Location, 1986 - 1992, Toledo Harbor, OH*

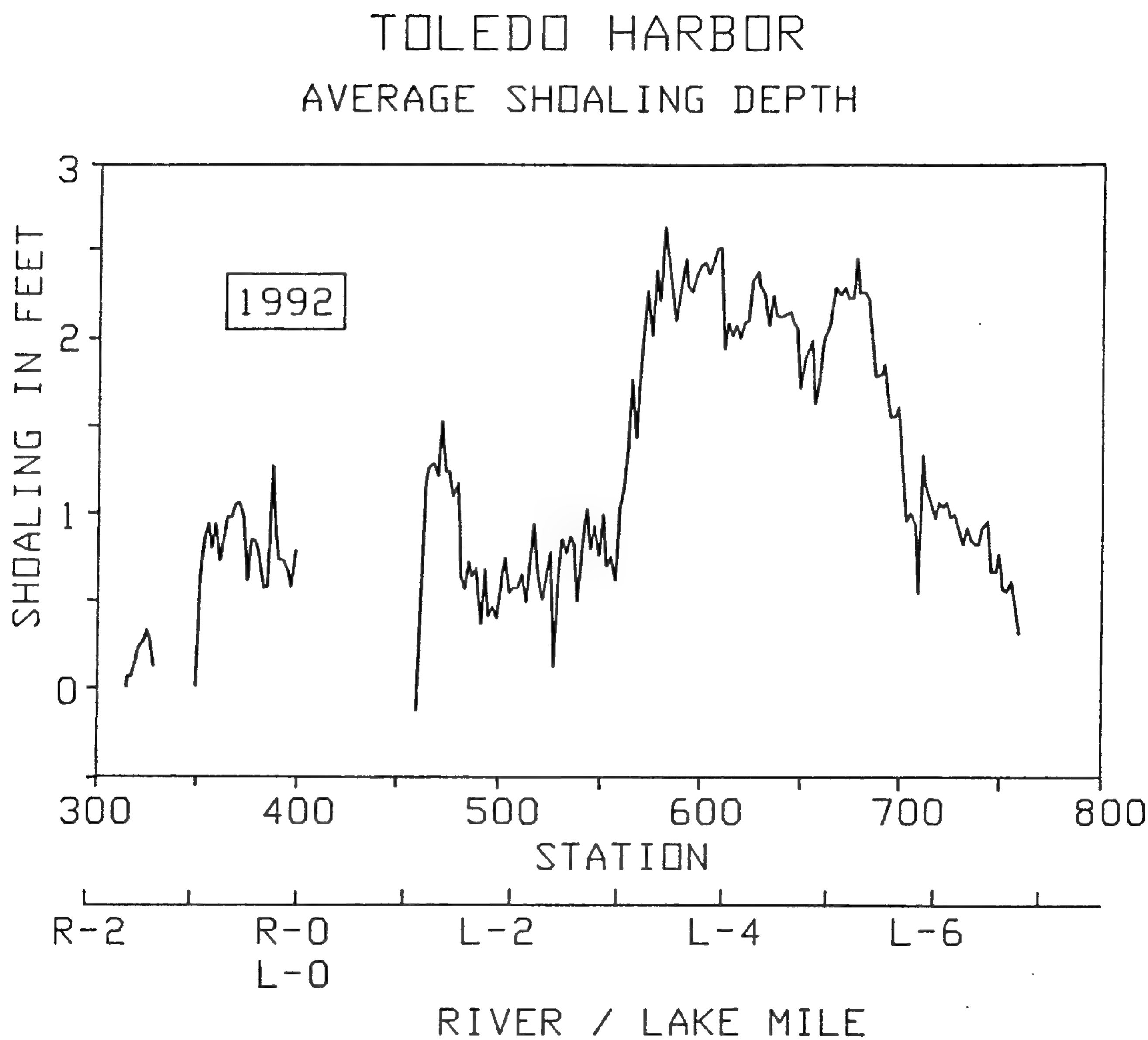


Figure 10 - Average Shoaling Depth, 1992

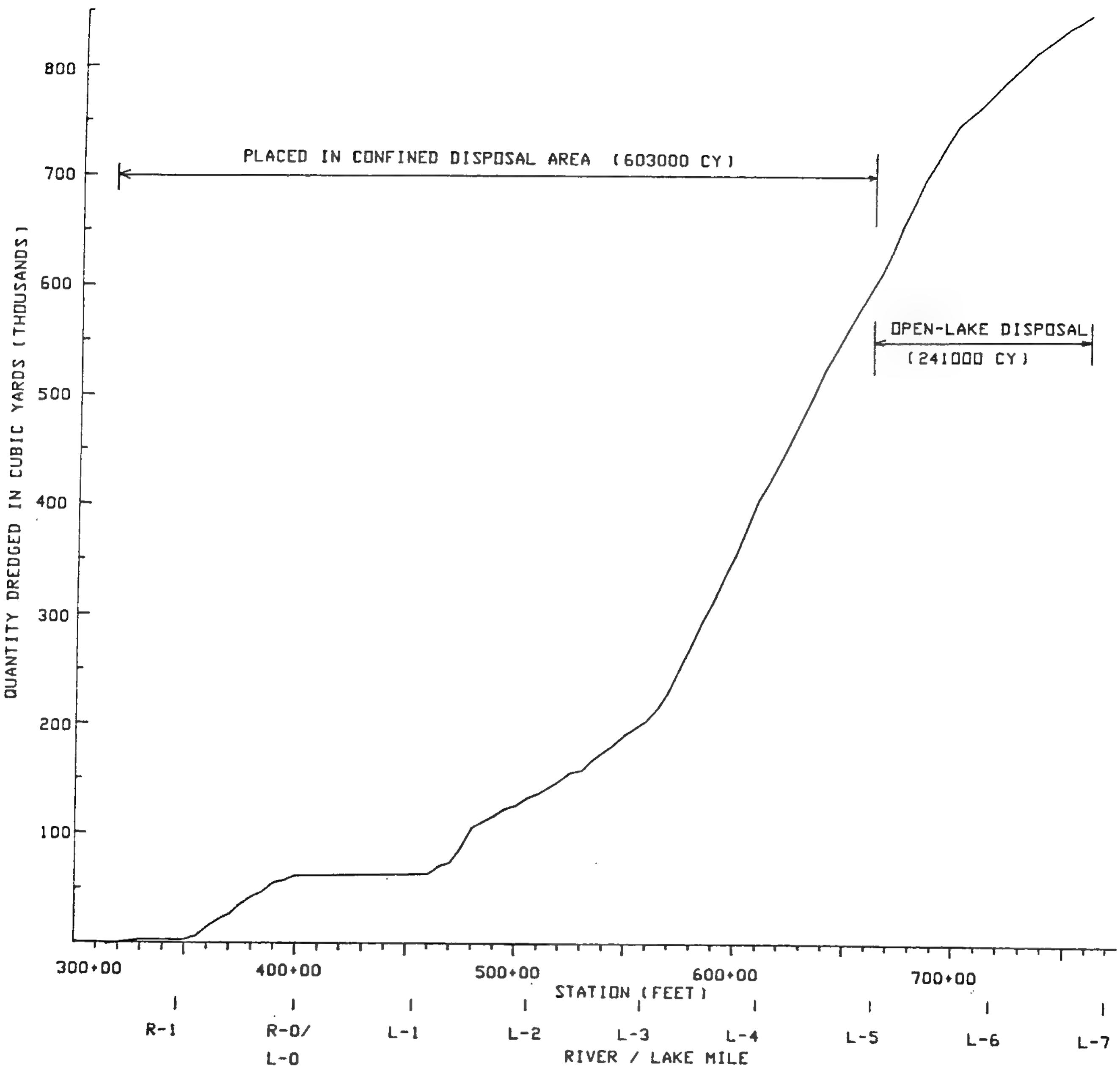


Figure 11 *- Toledo Harbor Channel Cumulative Dredging Volume, 1993*

Channel cross-sections were superficially investigated to ascertain if a pattern of deposition was apparent. *Figure 12 and Figure 13* present a river cross-section at station 374+00 and a lake channel cross-section at station 600+00, respectively. (See Figure A1, Appendix A for cross-section 700+00). No particular shoaling pattern is apparent in the river as it is relatively uniform, with the least shoaling occurring at the centerline. Within the lake channel, filling of the channel occurs approximately equal on each side of the channel, indicating the transport of the lake bed material into the channel is equally distributed from either side. The effect of vessel passage on the redistribution of the sediment in the channel is unknown.

In order to test the hypothesis that shoaling in the lake channel occurs by the approximately equal transport of lake bed material into the channel from either side, wave data were scrutinized. The recently completed Wave Information Study (WIS), (Driver, et. al. 1991) summarized thirty-two years of hindcast wind and wave information at three hour intervals for 53 locations along the shoreline of Lake Erie. The station located closest to Toledo Harbor, WIS Station E01 (41.73N, 83.27W) is shown on *Figure A2 in Appendix A.* The wave information has been summarized into the percent occurrence of waves in height and period ranges for 22.5 degree direction bands. The values in the azimuth tables represent the percentage of the 32-year period during which waves occur from the specified azimuth range for the indicated height. The values have been multiplied by 1,000. All direction bands of waves arriving from north of the channel were combined as were all wave direction bands from the south. As seen from *Table A3, Appendix A,* the total percentage of waves coming from the north or south of the channel is fairly equal with only a very slight preference for waves from the north. The distribution of wave heights from either direction is also very similar as seen in *Figure A3 in Appendix A.* This indicates that transport of lake bed material into the channel should be approximately equal from either side of the channel.

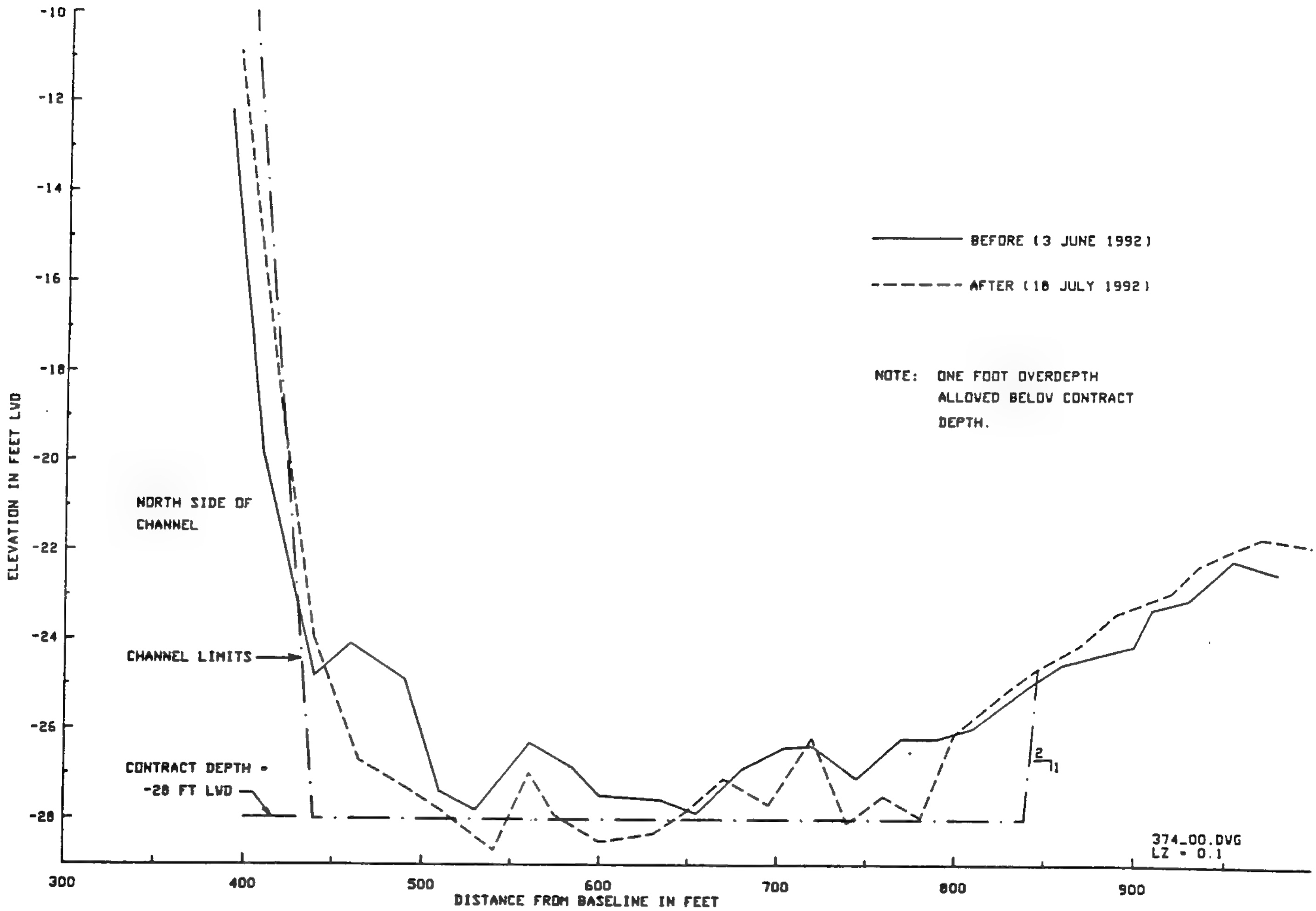


Figure 12 - Channel Cross-section at Station 374+00, 1992

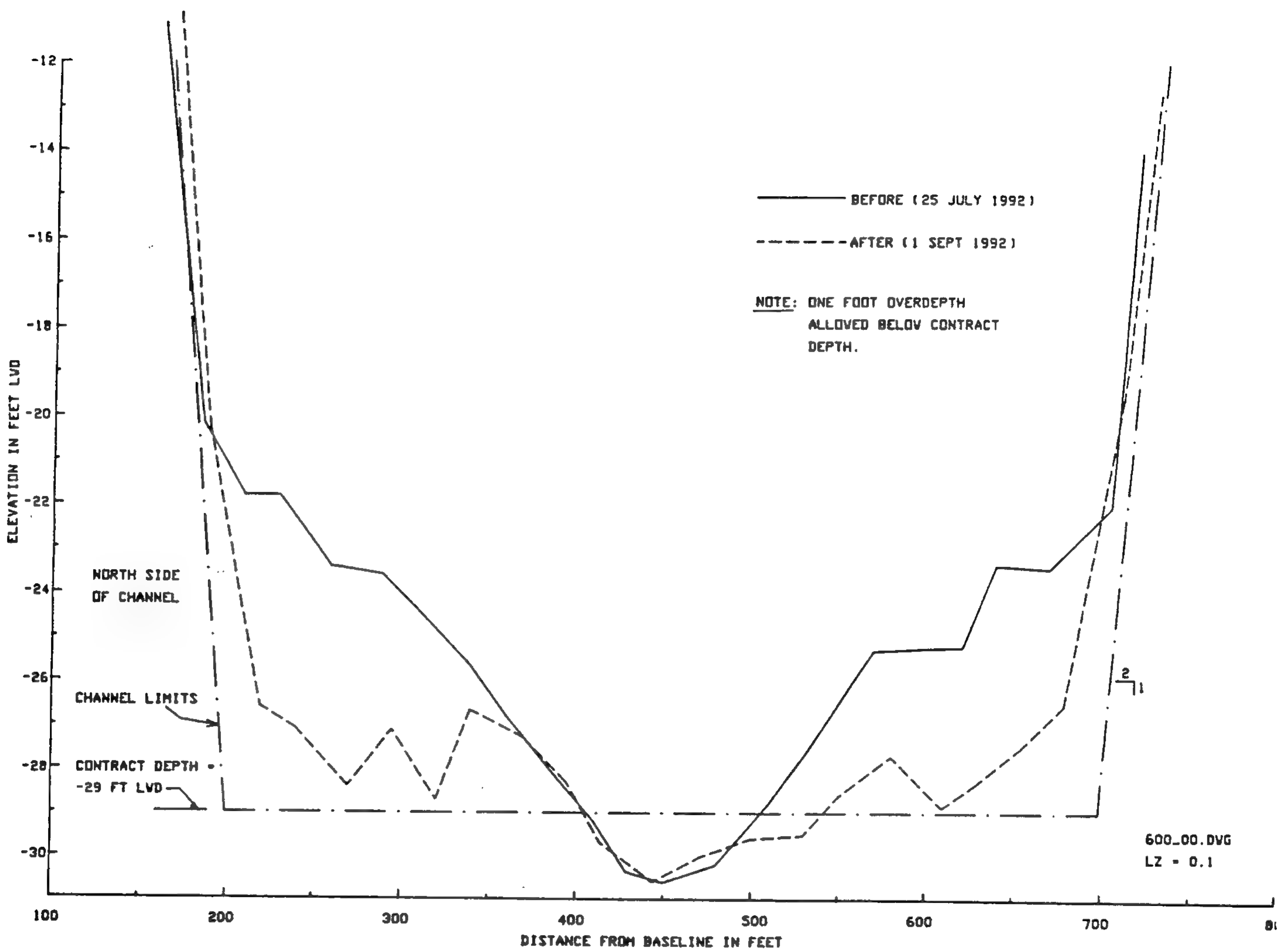


Figure 13 - Channel Cross-section at Station 600+00, 1992

C. MATERIAL CHARACTERISTICS

This portion of the report describes the characteristics of the dredged material obtained from sediment analyses performed under contract to the Corps of Engineers Buffalo District.

1. Federal Navigation Channel Dredged Materials

a. Sediment Sampling and Testing. In April 1988, a petite Ponar grab sampler was used to collect a total of 28 surface sediment composite grab samples from the authorized Federal navigation channels of Toledo Harbor *(Figure 14)*, as well as an open-lake discharge site *(Figure B1 in Appendix B)* (Aqua Tech Environmental Consultants 1988). Use of the open-lake discharge site shown in *Figure B1* was discontinued in 1988, but the site is used to address the characteristics of the dredged material that was discharged at the site between 1985 and 1988. With regard to the existing open-lake discharge site *(Figure B1)*, there are no data available on the dredged material on the bottom of the site which accumulated as a result of open-lake discharge operations between 1989 and the present. However, there are physical, chemical, bioassay and biological data available on sediments at this site prior to its use in 1989 for dredged material discharge activities (T.P. Associates, International Inc. 1987). Sampling Sites D-1 through D-4 represent the open-lake discharge site used for dredged material discharge between 1985 and 1988, Sites L-1-M through L-16-M the Lake Approach Channel, and Sites O-M through R-7-M the River Channel. Water depths at the sampling sites ranged from 17 to 25 feet. Individual homogenized composite samples consisted of three samples taken within a 50-foot radius of the designated sediment sampling site. One liter of sediment from each sampling site was subjected to bulk inorganic and organic analyses, as well as elutriate testing (Aqua Tech Environmental Consultants 1988). Four liters of sediment from each sampling site were used for acute toxicity tests (bioassays).

b. Sediment Physical Characteristics. Grain size distributions of the sediment samples were determined using CRL Method 485. Under this method of analyses, particles passing through a #200 sieve are considered fine-grain (i.e., silts and clays), and those retained are considered coarse-grain (i.e., sands and gravels). The results of the physical analysis are presented in *Table B1, Appendix B.* On the average, the channel sediment samples consisted of 88 percent silts and clays, with the remainder coarse-grain material. With few exceptions (i.e., Sampling Sites L-16-M, L-13-M, R-6-M and R-5-M), the sediment samples were comprised of about 80 to 98 percent silts and clays. The open-lake discharge site sediment

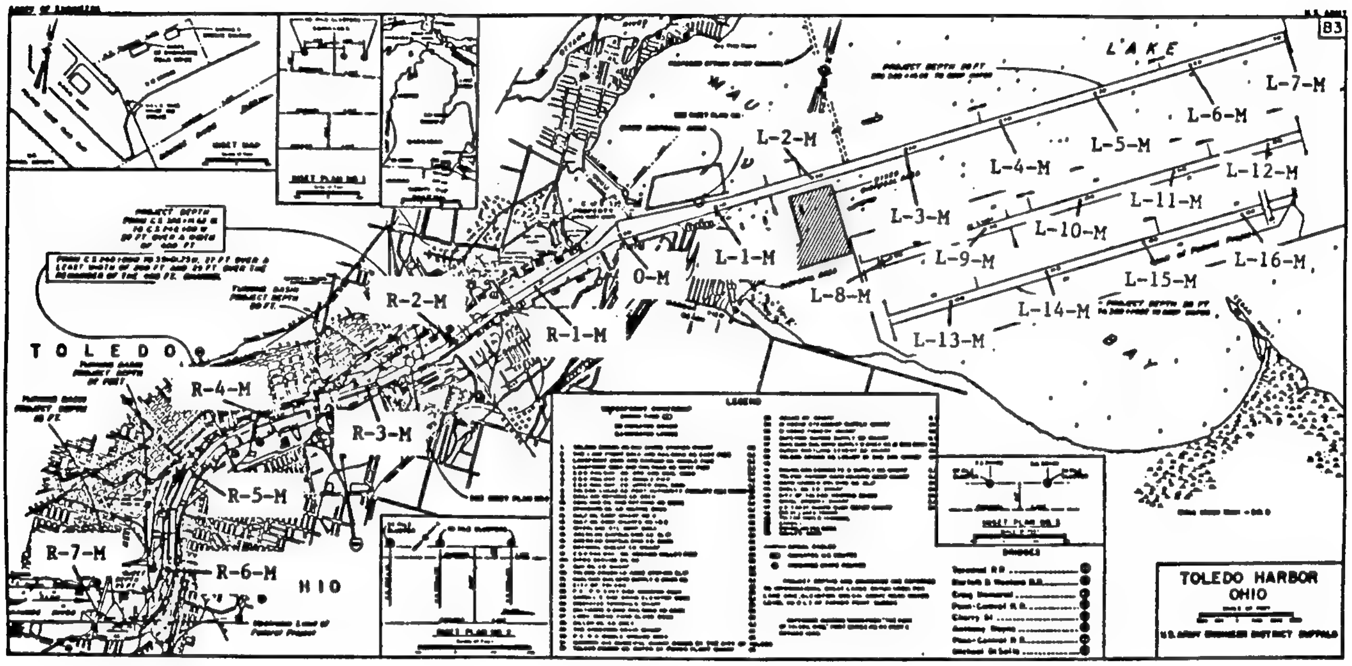


Figure 14 - Toledo Harbor Sediment Sampling Site

samples consisted of an average of 96.8 percent silts and clays, with the remainder coarse-grain material. In situ silty material that is routinely maintenance dredged is minimally compacted, similar to the physical properties of a fluid mud. During the discharge process, water is usually added to the material (either in the water column or in a hydraulic pipeline) and it takes on the physical properties of a disaggregated mud slurry (USAEWES 1992).

c. <u>Sediment Chemical Inventory</u>.

(1) *Inorganic Analyses.* All sediment samples were analyzed for total solids, total volatile solids, Chemical Oxygen Demand (COD), nitrate/nitrate nitrogen, ammonia-nitrogen, total Kjeldahl nitrogen (TKN), oil/grease, phenols, and total phosphorus, cyanide, mercury, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, nickel and zinc. Dry weight bulk inorganic data on the sediment samples are summarized in *Table B2, Appendix B.* High levels of arsenic, barium, cyanide and phosphorus, and moderate to high levels of ammonia-nitrogen, COD and iron were measured in most of the sediment samples. The apparently high concentrations of arsenic and cyanide in the sediment samples are comparable to local Lake Erie background levels (reference Buffalo District, 1972-1990 sample test results). Copper, manganese, nickel, total volatile solids, TKN, and zinc generally showed moderate levels in the sediment samples. Low levels of cadmium, lead, mercury, and oil/grease were measured in most of the sediment samples. Overall, heavy metal and nutrient contamination is highest in the River Channel sediment samples, particularly from the lower reach. Lake Approach Channel, open-lake discharge site and upper River Channel sediment samples show relatively lower inorganic contamination in comparison to the lower reach of the River.

(2) *Organic Analyses.* All sediment samples were subjected to a diverse array of organic analyses, including Pesticides, Polychlorinated Biphenyls (PCBs), Purgeable Halocarbons, Polynuclear Aromatic Hydrocarbons (PAHs) and Phthalate Esters. Dry weight bulk Pesticide and PCB data are summarized in *Table B3, Appendix B. Table B4, Appendix B* presents the dry weight bulk Purgeable Halocarbon data. No Pesticides, PCBs or Purgeable Halocarbons were detected in any of the sediment samples. The results of the dry weight bulk PAH and Phthalate Ester analyses are presented in *Table B5, Appendix B.* These data show PAHs at nondetectable to very low levels (i.e., around or below 1 ppm) in the Lake Approach Channel and open-lake discharge site sediment samples. Phthalate Esters were also generally nondetectable, or at levels around or below 2 ppm in these sediment samples. In River Channel sediment samples, a more diverse array of PAHs were detected at concentrations generally around or below 3 ppm. However, Bis(2-ethylhexyl)Phthalate, the only Phthalate Ester detected in any of the sediment samples (except Di-n-octyl Phthalate at Sampling Site R-1-M), was measured at 17.8 ppm at Sampling Site R-1-M in the River Channel. Generally, PAH and Purgeable

Halocarbon contamination was higher in sediment samples from the lower River Channel, as compared to those from the upper reach. The most predominant PAHs measured in the sediment samples include Naphthalene, Phenanthrene, Pyrene, Flouranthene and Chrysene.

d. Sediment Elutriate Testing. The primary objective of elutriate testing is to simulate and/or predict inorganic contaminant releases from the sediments during dredging and dredged material open-water discharge processes. The elutriate test data are summarized in *Table B6, Appendix B*. Moderate to high releases of barium, iron, manganese, nitrogen-ammonia, TKN and zinc were measured from most of the sediment samples. Chromium, mercury, nitrate, and oil/grease generally showed lower releases. Phosphorus releases were nondetectable from all of the Lake Approach Channel sediment samples, and nondetectable or low in the Upper River Channel samples. When compared to elutriate data on sediment samples from the Lake Approach Channel and open-lake discharge site, the River Channel sediment samples generally showed higher releases for most of the parameters measured.

e. Sediment Bioassays. Ninety six-hour water column bioassay were performed on all of the samples to evaluate the potential toxicological effects of the sediments on selected aquatic species. These bioassays were conducted according to procedures described by Prater and Anderson (1977a,b). Test species utilized in the bioassay include the burrowing mayfly (Hexagenia limbata Walsh), water flea (Daphnia magna Straus) and fathead minnow (Pimephales promelas Rafinesque). Mortality data (in percentages) on these test species were compared to the pollutional classification scheme used in Prater and Anderson (1977a,b). According to this categorization, sediments from all of the sampling sites are classified as "nonpolluted" with respect to fathead minnow mortalities, since the measured mortalities were within the ten percent range for this species. All but two of the sediment samples were classified as "moderately polluted" within the 10-50 percent mortality range for the burrowing mayfly. Sediments from Sampling Sites R-1-M and R-4-M were classified as "heavily polluted" since they exceeded the 50 percent mortality value for the mayfly. D. magna mortalities classified all but four of the sediment samples as "nonpolluted" within the ten percent mortality range for this species. Sampling Sites L-9-M, O-M, R-3-M and D-2 were classified as "moderately polluted" with respect to D. magna mortalities. In summary, these bioassays indicate that sediment samples in the Lake Approach Channel and open-lake discharge site are classified overall as "nonpolluted" to "moderately polluted" with respect to the test species mortalities. River Channel sediment samples, particularly from the lower reach, are categorized overall as "moderately polluted" to "heavily polluted."

2. Confined Disposal Facility Sediments (Consolidated Dredged Materials)

a. Sediment Sampling and Testing. In October 1984, Buffalo District

personnel used a bucket auger to collect five core soil/dredged material samples from the Island 18 CDF and currently used CDF at Toledo Harbor, Ohio. These samples represent dredged material which was placed in the CDFs prior to 1984. The soil sampling sites within these facilities are shown in *Figure 15*. Sampling Sites I through III represent the material in the Island 18 CDF, and IV and V represent material in the currently used CDF. The core samples were separated into intervals with respect to depth from the soil surface for a total of 18 samples, as summarized in *Table B7, Appendix B*. All soil samples were subjected to bulk physical and chemical (inorganic and organic) analyses. Column leach testing was performed on three of the soil samples. All analyses were conducted by Aqua Tech Environmental Consultants (1984).

b. Sediment Physical Characteristics. Grain size distributions of the soil samples were determined using CRL Method 485. The results of the physical analysis are presented in *Table B8, Appendix B*. On the average, the CDF soil samples consisted of 81 percent silts and clays, with the remainder coarse-grain material. With few exceptions (i.e., Sampling Sites IV-2, IV-3 and IV-4), the sediment samples were comprised of between about 91 and 98 percent silts and clays. With the exception of the most recently discharged mud slurry material, the majority of material in CDFs is dewatered and consolidated to some degree, which depends on depth and elevation, among other factors.

c. Sediment Chemical Inventory.

(1) *Inorganic Analyses.* All soil samples were analyzed for total solids, total volatile solids, ammonia-nitrogen, TKN, and total phosphorus, cyanide, mercury, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, nickel and zinc. Dry weight bulk inorganic data on the soil samples are summarized in *Table B9, Appendix B*. Higher levels of barium and phosphorus, and moderate to

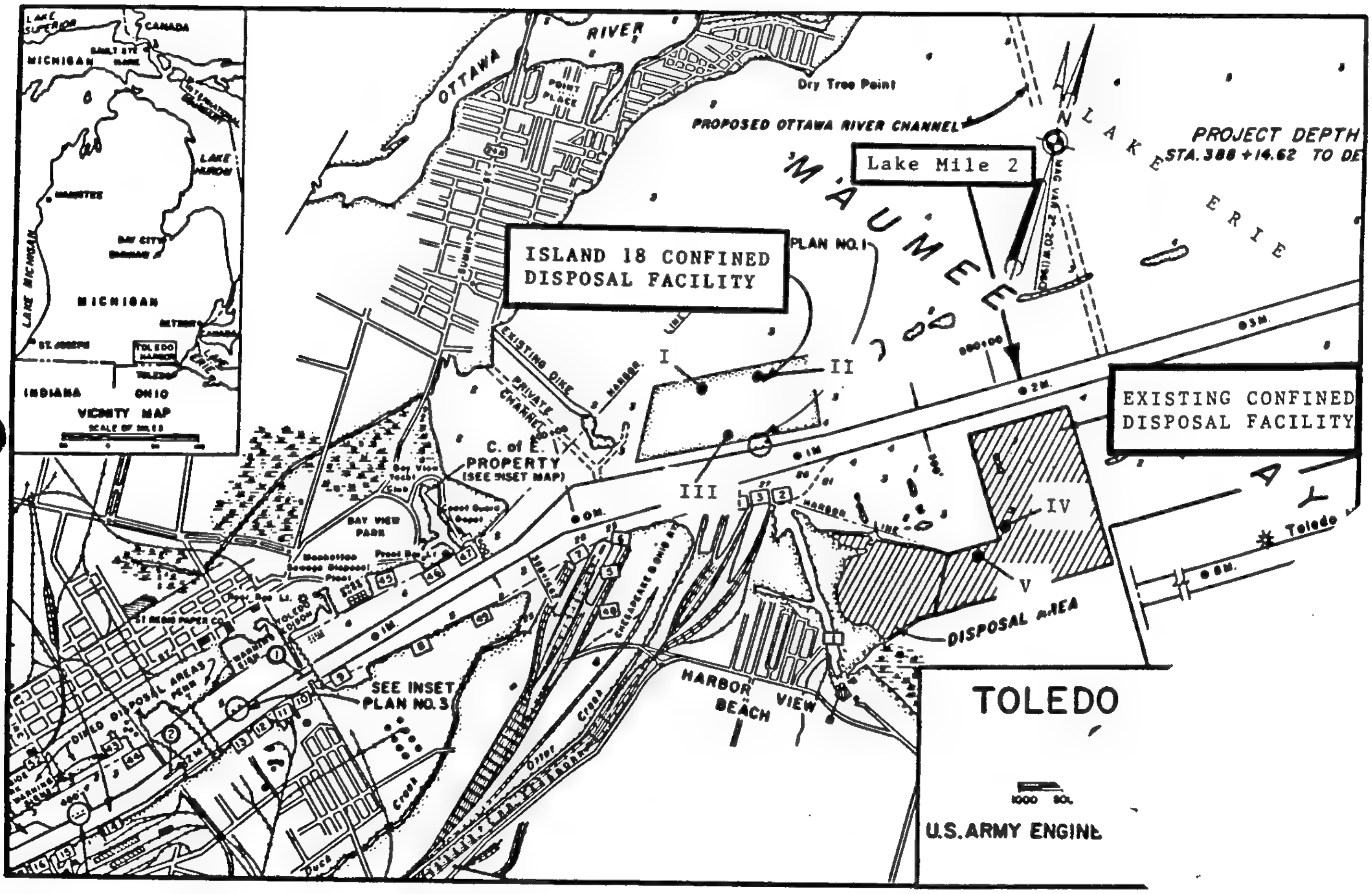


Figure 15 - Toledo Harbor CDF Soil Sampling Sites

high levels of arsenic and zinc were measured in most of the soil samples. Total volatile solids, copper, iron and nickel generally showed moderate levels in the soil samples. Moderate to low levels of chromium, lead, manganese and TKN, and low concentrations of cadmium and mercury were measured in most of the soil samples. At most of the sampling sites, concentrations of ammonia-nitrogen increased with respect to depth. None of the other inorganic parameters tested in the soil samples showed a clear trend.

(2) ***Organic Analyses.*** All sediment samples were subjected to an array of organic analyses, including Pesticides, PCBs, PAHs and oil/grease. Dry weight bulk Pesticide and PCB data are summarized in *Table B10, Appendix B.* The Pesticide 4,4'-DDD was measured in most the soil samples, but at low levels (i.e., below 1 ppm). The PCBs Aroclor 1242 and 1260 were also present in most of the samples, but at levels around or below 1 ppm, with the exception of Sample III-2, which showed a concentration of 2.3 ppm. Based on the soil samples analyzed, overall, the Island 18 CDF appears to show more PCB soil contamination than the currently used CDF. The results of the dry weight bulk PAH analyses are presented in *Table B11, Appendix B.* Phenanthrene, Chrysene, Benzo(b)Flouranthene and Pyrene were the most common PAHs measured in the soil samples. Chrysene and Pyrene showed the highest concentrations in the samples, which ranged between nondetectable to about 4 and 8 ppm, respectively. The other PAHs showed levels between about 1 and 2 ppm. Based on the soil samples analyzed, overall, the Island 18 CDF showed more PAH soil contamination than the currently used CDF. With regard to oil/grease, levels were generally variable, ranging from low to high throughout the soil samples.

(3) Column Leach Testing. Preliminary column leach testing was conducted on some of the soil samples to determine the effects of contaminant leaching if the material were to be placed in a landfill. In the laboratory, artificial rain was allowed to percolate through a column of material and the leachate is collected over a period of time for subsequent analyses. This procedure was performed on soil samples I-7, II-2 and IV-4 twice at sampling intervals of about every two weeks. The results of the column leach tests are summarized in *Tables B12 and B13, Appendix B.* Of the analytes measured in the leachate after the sampling intervals, most were well below 1 ppm, with the exception of iron, which ranged from about 0.3 to 2.6 ppm, and solids (total, total volatile and suspended), ammonia-N, TKN and phosphorus. These preliminary results appear to indicate minimum leachable constituents.

D. CURRENT DREDGING REQUIREMENTS

Near term dredging quantities are expected to mirror recent efforts. Hence it is expected that the average annual total dredging quantity will be on the order of 850,000 cubic yards. Average shoaling rates of 0.5 to 1 foot per year in the downstream end of the river and the beginning of the lake channel can be expected. More rapid shoaling on the order of 2 to 2.5 feet per year can be expected in the portion of the lake channel from about lake mile 3 to lake mile 5.5. Further shoaling lakeward will occur at a lower rate.

Dredging is normally accomplished by hydraulic or mechanical means. Placement of dredged material in the available CDFs is accomplished by hydraulic pipeline and mechanical disposal. Placement of dredged material at the open-water disposal site is accomplished by dredging the material mechanically, and placing it into a barge for dumping at the disposal site, or hydraulically by pumping the material through a pipeline from the channel to the disposal site.

E. AVAILABLE DISPOSAL RESOURCES

1. Confined Disposal Facilities

Confined disposal is placement of dredged material within diked nearshore or upland CDFs via pipeline or other means. The term CDF is used in this document in its broadest sense. CDFs may be constructed as upland sites, nearshore sites with one or more sides in water (in-lake CDFs), or as island containment areas.

The two objectives inherent in design and operation of CDFs are to provide for adequate storage capacity for meeting dredging requirements, and to maximize efficiency in retaining the solids. However, if contaminants are present, control of contaminants may also be a design objective.

Hydraulic dredging adds several volumes of water for each volume of sediment removed, and this excess water is normally discharged as effluent from the CDF during the filling operation. The amount of water added depends on the design of the dredge, physical characteristics of the sediment, and operational factors such as pumping distance. When the dredged material is initially deposited in the CDF, the fluid-sediment mixture may occupy several times the original volume of the sediment. The settling process is a function of time, but the sediment will eventually consolidate to its in situ volume or less if desiccation occurs. Adequate volume must be provided during the dredging operation to contain the total volume of sediment to be dredged, accounting for any volume changes during placement.

Some CDFs are filled by mechanically rehandling dredged material from barges filled by mechanical dredges. Material placed in the CDF in this manner is at or near its in situ water content. If such sites are constructed in water, the effluent volume may be limited to the water displaced by the dredged material, thus the settling behavior of the material is not as important.

In most cases, CDFs are used over a period of many years, storing material dredged periodically over the design life. Long-term storage capacity of CDFs is therefore a major factor in design and management. Once water is drained from the CDF following active disposal operations, natural drying forces begin to dewater the dredged material, adding additional storage capacity. The gains in storage capacity are therefore influenced by consolidation and drying processes and the techniques used to manage the site both during and following active disposal operations.

Several CDFs have been in active use at Toledo Harbor. These include the Grassy Island CDF (also called Island 18), the existing Toledo CDF #1, the new Toledo CDF #2 (presently under construction), and the Port Facility #3. These sites are located as shown on *Figure 3.* A brief description of each of these CDFs follows:

a. Grassy Island CDF - The Grassy Island CDF is a generally rectangular in-lake island CDF situated in Maumee Bay near the mouth of the Maumee River, approximately 400 feet north, adjacent and parallel to the existing Federal navigation channel near Lake Mile 1 (*Figure 3*). A schematic of the site is shown in *Figure 16.*

Island 18 is a 132-acre diked enclosure (150 acres total) originally constructed in stages by the U.S. Army Corps of Engineers, Detroit District for the disposal of Toledo Harbor dredged material. The enclosure dike was was originally contructed in 1961 through 1962 to +7 feet LWD, and was subsequently raised in 1966 to +15 feet LWD. The dike was completed in 1969 when it was raised to +23 feet LWD. The dike is constructed primarily of a clay core capped with topsoil which has been fertilized and mulched, and is comprised of three berms. The top and middle berms have side slope of 1V:2H; crest height are +23 feet and +13 feet LWD, and crest width are 8 and 14 feet, respectively. A grade drainage ditch separates the top and middle berms. The lower berm is constructed of cover and underlayer stone over filter plastic material, has a crest height of +9 feet LWD and a crest width of approximately 13 feet, and has an outer slope of 1V:2H.

Between 1962 and 1974, Island 18 was used for the disposal of material dredged from portions of Toledo Harbor Lake Approach and River Channels closest to the facility. Three other sites along the River were also known to have been used to dispose of material. During the period 1975-1977, material throughout the Toledo

Harbor Federal navigation project was placed in the facility.

Grassy Island is currently filled to an average elevation of approximately +19 feet LWD. The most recent site survey indicated a minimum remaining volumetric capacity of 295,000 cubic yards, assuming fill to elevation +20 feet LWD (weir crest). The site has a developed high quality wildlife habitat. Resource agencies have indicated that the site is under consideration for habitat enhancement. The site is also being considered as a dredged material recycling area. This option would be more fully evaluated in Phase 2. <u>Use of Grassy Island should be considered in the formulation of intermediate/transition plan(s), because it has a remaining useful capacity.</u>

<u>b. Existing Toledo CDF #1</u> - The existing Toledo CDF #1 is an L-shaped in-lake CDF located south of the Maumee River Channel (Figure 3). A schematic of the site is shown in *Figure 17.* This site was constructed in 1976 and has been used continuously since 1978. The dikes are of rubblemound construction. The site comprises a total area of 240 acres. The CDF is currently filled to an average elevation of +22 feet LWD in its western portion, and to an average elevation of +14 feet LWD in its eastern portion. The western portion can be considered filled at the present dike elevation of +23.50 feet LWD. Based on the most recent survey, the eastern portion has a remaining capacity of approximately 1 million cubic yards.

<u>c. New Toledo CDF #2</u> - The new Toledo Harbor CDF #2 is an irregularly shaped CDF, currently under construction, and is adjacent to the existing Toledo Harbor CDF #1 *(Figure 3)*. A schematic of the site is shown in *Figure 17.* This site will be completed in 1993, and will comprise a total area of 155 acres. The existing lake bottom is at average elevation of -2.5 feet LWD. The site has a capacity of approximately 8.7 million cubic yards to a fill elevation of +22.3 LWD. Approximately 20% of that volume or 1.7 million cubic yards is below an average lake level of +2.0 feet LWD.

<u>d. Port Facility #3</u> The Port CDF is a rectangular-shaped CDF located adjacent to the existing Toledo CDF #1. A schematic of the site is shown in *Figure 17.*

<u>e. Open Water Disposal Site</u> - Approximately 600,000 cu yd of dredged material from lake mile 2 has been placed at the open-water site shown in figure 3 from 1985 to 1991; 300,000 cu yd of dredged material from lake mile -5 lakeward has been placed at the open-water site in 1992. **According to the recent "Section 401 Certification", dredged material from Lake mile-5 lakeward will be allowed to be placed at the open-water disposal site through 1994, after which time no further disposal would be allowed at the site.**

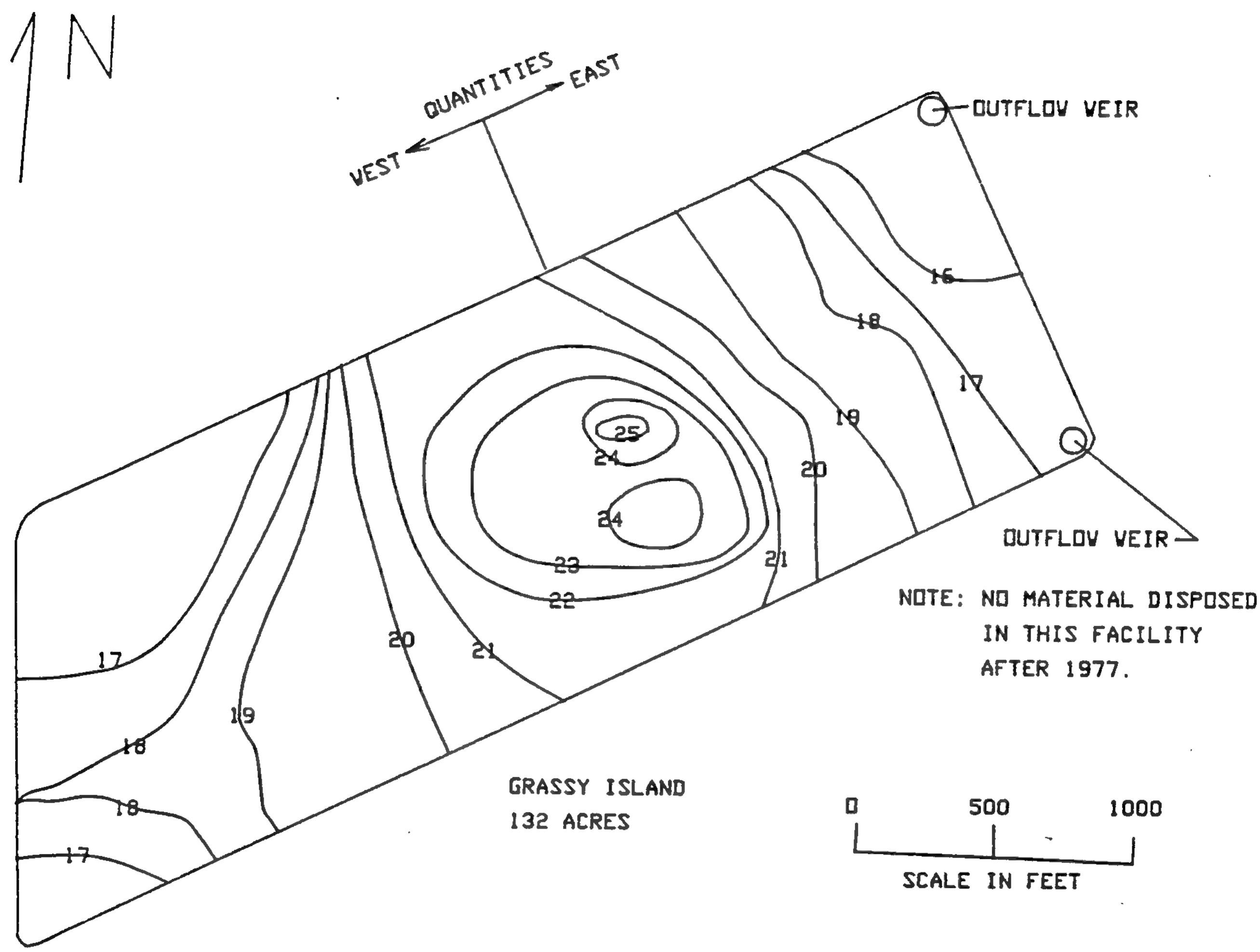


Figure 16 - Island 18 Disposal Site

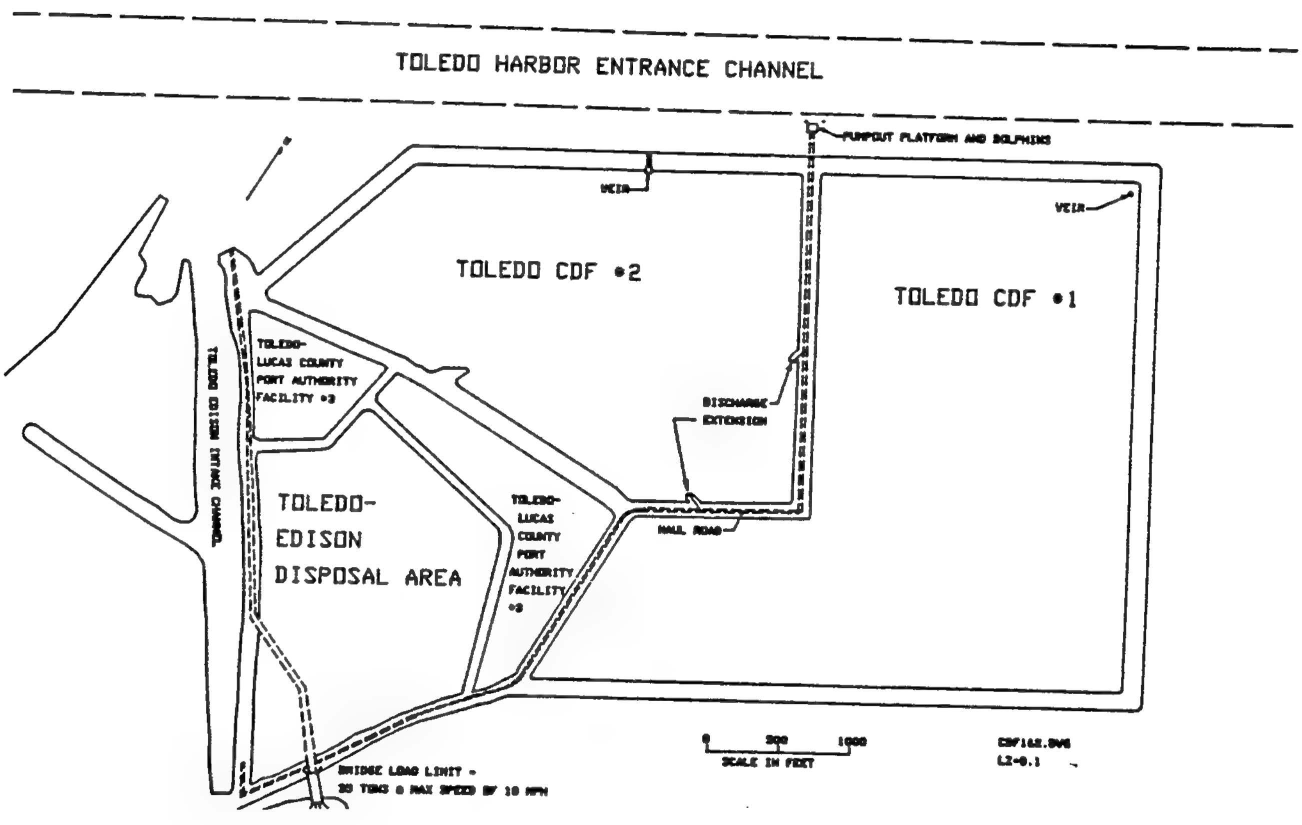


Figure 17 - Port Authority Facility # 3 and Corps of Engineer CDF's # 1 and # 2

F. OVERVIEW OF PREVIOUS STUDIES

Available literature was collected and reviewed. A listing of available literature can be found in the Reference section of this report. A brief synopsis of each reference is given in Appendix E. Literature was collected that described the project, dredged material testing and evaluation for open-water and CDF disposal, beneficial uses of dredged material, mitigation for CDF construction, monitoring at the open-water disposal site, and remedial action plans for the Maumee River. The information from this available literature will be discussed under the section in this report related to that particular information.

G. ENVIRONMENTAL RESOURCES AND CONCERNS

1. Description of Environmental Resources

The information summarized here (unless indicated otherwise) was taken from a previously prepared Final Environmental Impact Statement (COE, 1990) for new Toledo Harbor CDF (USACE, 1990), currently under construction.

a. Benthos - Benthic macro-invertebrates found within the Maumee River and Maumee Bay areas include such species as Oligochaete worms, dipteran, and chironomid larvae. High pollution levels in Maumee Bay during the 1930-1961 period was evidenced by high oligochaete worm densities and by loss of pollution intolerant organisms such as the mayfly nymph (Hexagenia). Densities of oligochaetes showed a marked decrease in the Maumee River by 1982.

Table 1 provides some information on the density (expressed in mean number per square meter) of bottom dwelling (benthic) organisms in Maumee Bay and the open lake area in 1930, 1961, and 1982, which was obtained from data in an unpublished report by B.A. Manny, Great Lakes Fisheries Center, Ann Arbor, Michigan. *Figure 18* provides numbers of Oligochaete and Diptera (i.e., flies, mosquitoes, midges) found per square meter at various sampling locations in Maumee Bay during May 1975 (Pinsak and Meyer, 1976).

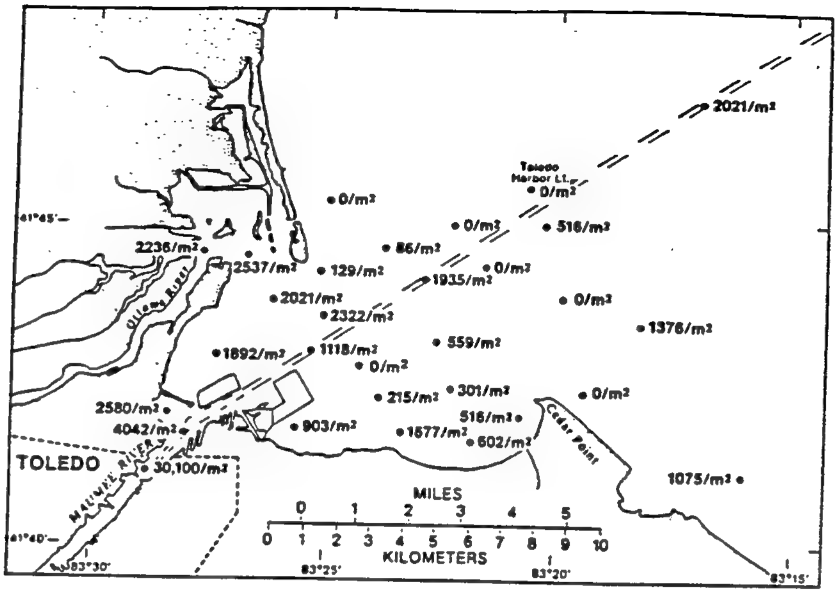
b. Fisheries - While factors such as water quality and obstruction to traditional spawning areas up the Maumee River have resulted in the extirpation and/or decline of some fish species, the fish community contains a diversity of species. A total of at least 59 species of fish have been collected in Maumee Bay since 1974. Forty-two of these species have been found in the area of the new CDF currently under construction, including moderate numbers of sport species such as walleye, white bass, yellow perch, channel catfish, white crappies, and freshwater drum.

Table 1 - Mean Number of Benthic Organisms in Maumee Bay and the Open Lake (Erie)

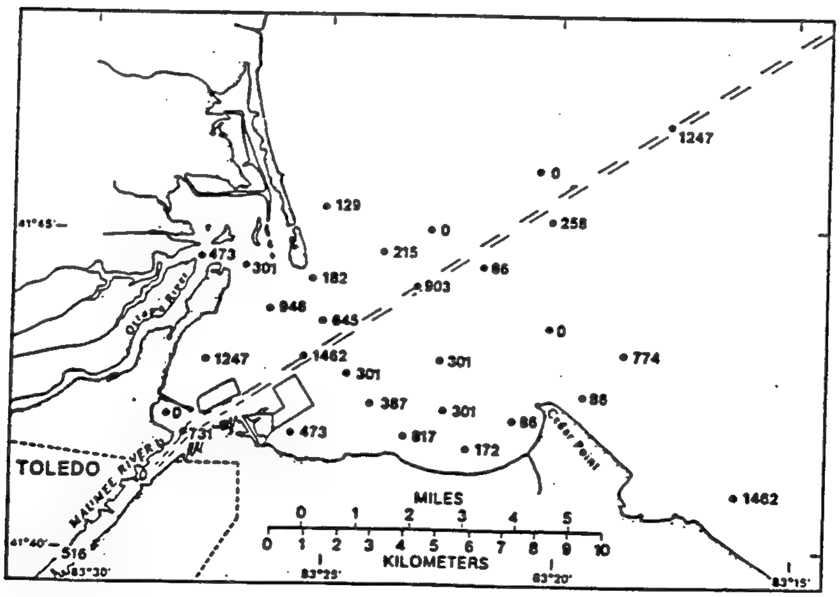
Benthic Organism	Maumee Bay			Open Lake		
	1930	1961	1982	1930	1961	1982
Oligochaeta (Aquatic Worms)	1658	5033	2244	6	1133	2361
Hexagenia (Mayflies)	123	1.8	0.6	394	1.2	0
Tendipedidae (Midges)	84	359	278	14	337	143
Sphaeridae (Clams)	491	37	122	57	857	71

The sheltered environment of the existing CDFs may be conducive to spawning for white crappie and channel catfish. Walleye and white bass in spawning condition have been collected in these area (USFWS, 1987), and walleye eggs were collected on the majority of egg trees set on the rocky shoals that parallel the Federal navigation channel (Fraleigh et al., 1979). It should be noted, however, that a somewhat more recent report entitled "Maumee River Remedial Action Plan" - Stage I Investigation Report (OEPA/MRRAPAC, 1990) mentions about a 50-percent drop in fish species during the period 1950-1990 according to a documented investigation. The report further states that this decline might be due to a wastewater treatment plant plume movement upstream and a number of sewer overflow discharges.

In spite of obvious water quality problems in the lower Maumee River and Maumee Bay, these areas serve as nursery habitat and perhaps spawning habitat for white bass and other sport and commercial species such as walleye, yellow perch, freshwater drum, and channel catfish. The average density of larval white bass in Maumee Bay was more than five times greater than the average density east of the bay, and more than seven times greater than the average density north of the bay. A similar pattern was found for freshwater drum. For larval walleye, the density found in Maumee Bay was slightly greater than that north of the bay, but considerably less than that east of the bay (Mizera, 1981).



Oligochaeta in Maumee Bay, May 1975.



Diptera in Maumee Bay, May 1975.

Figure 18 - Oligochaete and Diptera Distributions in Maumee Bay, 1975

Maumee Bay also appears to be a spawning and/or nursery area for forage fish, particularly gizzard shad. The average density of gizzard shad larvae in Maumee Bay in 1977 was almost three times that of the areas east and north of the bay (Heniken, 1977). Gizzard shad are the most important forage species for walleye in the western basin of Lake Erie (USFWS, 1987).

Table 2, entitled "Fish Species Expected to Occur in nearshore and offshore Areas of Maumee Bay" was extracted from the USFWS's Draft Fish and Wildlife Coordination Act Report dated 15 July 1987, that was submitted to the Buffalo District Corps of Engineers on the new Confined Disposal Facility in Maumee Bay at Toledo, Harbor. The table provides a compilation of 62 species of fish that might occur in that area, based on information gleaned from the following reference sources: (1) Fish Species Expected to Occur in Maumee Bay During Spring; from Fraleigh, et al. (1975) based on Scott and Crossman (1973); (2) Fish Inhabiting Maumee Bay Since 1957; from Pinsak and Meyer (1976) based on Trautman (1957); (3) Fish Believed to Presently Inhabit Maumee Bay; from Pinsak and Meyer (1976); and (4) Fish Expected to Utilize Vegetated Sandy Mud, Gravel, and Silt Areas in Maumee Bay; from Hartley and VanVooren (1977). As indicated by the USFWS (USFWS, 1987), "a number of these species, including lake sturgeon, spotted gar, American eel, eastern sand darter, and Iowa darter would be very rare, if present at all, in the area over the last 10 to 15 years." Further, "approximately 48 to 57 species of fish might reasonably be expected to occur in the existing fish community of Maumee Bay. Note that the majority of the species believed to have been extirpated from the community or in significant decline are species preferring clean water with clean gravel or rooted aquatic macrophytes for cover, feeding, and spawning habitat." The final Fish and Wildlife Coordination Act Report (USFWS, 1987) points out that "the northern hogsucker and black redhorse are probably strays as their species are generally found further upstream in higher gradient habitat. The three spine stickleback is possibly the result of releases of the fish by bait dealers or in ballast water, as the species is recorded by Hubbs and Lagler (1958) as occurring only in the Lake Ontario basin. Such releases may also explain the presence of mottled sculpin, which has previously been recorded for the Maumee River drainage only in smaller streams of the upper drainage area and for the western basin of the lake only in the vicinity of the Bass Islands. Chinook salmon, coho salmon, and rainbow trout (steelhead) are present as the result of stocking over the past two decades and are generally not able to maintain self-perpetuating populations."

A number of fish species have sport and/or commercial value in the Maumee Bay area. Recent fisheries data for this area as summarized by the Ohio Department of Natural Resources (copy of ODNR letter dated 16 July 1992 to Ohio EPA received by the Corps of Engineers via personnel communication with the USFWS Sandusky, Ohio Biological Station), summarizes commercial harvest and/or sport harvest information for the years 1990 and 1991 on walleye, yellow perch,

Table 2 - Fish Species Expected to Occur in Nearshore and Offshore Areas of Maumee Bay

	Reference Source			
	1	2	3	4
Lake sturgeon (*Acipenser fulvescens*)		X		X
Spotted gar* (*Lepisosteus oculatus*)		X		X
Longnose gar (*Lepisosteus osseus*)		X		X
Bowfin (*Amia calva*)				X
American eel (*Anguilla rostrata*)		X		
Alewife (*Alosa pseudoharengus*)	X			X
Gizzard shad (*Dorosoma cepedianum*)	X	X	X	X
Mooneye* (*Hiodon tergisus*)	X	X		
Lake whitefish (*Coregonus clupeaformis*)		X	X	X
Chinook salmon (*Oncorhynchus tshawytscha*)				X
Rainbow trout (*Salmo gairdneri*)	X			X
Brown trout (*Salmo trutta*)				X
Rainbow smelt (*Osmerus mordax*)				X
Northern pike (*Esox lucius*)	X	X	X	
Muskellunge* (*Exox masquinongy*)		X	X	
Goldfish (*Carassius auratus*)	X	X	X	X
Common carp (*Cyprinus carpio*)	X	X	X	X
Silver chub* (*Hybopsis storeriana*)		X		X
Golden shiner (*Notemigonus crysoleucas*)		X		
Emerald shiner (*Notropis atherinoides*)		X		X
Spottail shiner (*Notropis hudsonius*)		X		X
Spotfin shiner (*Notropis spilopterus*)		X		X
Sand shiner (*Notropis stramineus*)		X		X
Redfin shiner (*Notropis umbratilis*)		X		
Mimic shiner (*Notropis volucellus*)				X
Bluntnose minnow (*Pimephales notatus*)		X		X
Fathead minnow (*Pimephales promelas*)				X
Quillback (*Carpiodes cyprinus*)	X		X	X
White sucker (*Catostomus commersoni*)	X	X	X	X
Bigmouth buffalo (*Ictiobus cyprinellus*)		X	X	X
Silver redhorse (*Moxostoma anisurum*)		X	X	X
Golden redhorse (*Moxostoma erythrurum*)			X	X
Shorthead redhorse (*Moxostoma macrolepidotum*)		X	X	X
Greater redhorse* (*Moxostoma valenciennesi*)		X	X	
Black bullhead (*Ictalurus melas*)		X		X
Yellow bullhead (*Ictalurus natalis*)				X
Brown bullhead (*Ictalurus nebulosus*)		X	X	X
Channel catfish (*Ictalurus punctatus*)	X	X	X	X
Stonecat (*Norturus flavus*)		X		X
Brindled madtom (*Noturus miurus*)				X
Trout-perch (*Percopsis omiscomaycus*)		X		X
Burbot* (*Lota lota*)		X		X
Brook silverside (*Labidesthes sicculus*)		X		X
White perch (*Morone americana*)				X
White bass (*Morone chrysops*)	X	X	X	X
Green sunfish (*Lepomis cyanellus*)		X		X
Pumpkinsee (*Lepomis gibbosus*)		X		X
Bluegill (*Lepomis macrochirus*)		X		X
Smallmouth bass (*Micropterus dolomieui*)		X		X
Largemouth bass (*Micropterus salmoides*)		X		X
White crappie (*Pomoxis annularis*)		X	X	X
Black crappie (*Pomoxis nigromaculatus*)		X	X	
Eastern sand darter* (*Ammocrypta pellucida*)				X
Iowa darter* (*Etheostoma exile*)				X
Johnny darter (*Etheostoma nigrum*)		X		X
Yellow perch (*Perca flavescens*)	X	X	X	X
Logperch (*Percina caprodes*)		X		X
Channel dater* (*Percina copelandi*)		X		X
Sauger (*Stizostedion canadense*)		X	X	X
Walleye (*Stizostedion vitreum*)	X	X	X	X
Freshwater drum (*Aplodinotus grunniens*)	X	X	X	X
Mottled sculpin (*Cottus bairdi*)				X

* Classified as Ohio endangered species.

white bass, freshwater drum, channel catfish, and white perch. Sport harvest in pounds (lbs.) for the aforementioned fish species in each of those years, respectively, was as follows: walleye (7,863 lbs.; 10,304 lbs.), yellow perch (2,849 lbs.; 7,759 lbs.), white bass (480 lbs.; 14,276 lbs.), freshwater drum (283 lbs.; 1,862 lbs.), channel catfish (4,667 lbs.; 202 lbs.), and white perch (93 lbs.; 416 lbs.). Although no commercial harvest information was reported for the Maumee Bay area in 1991, the 1990 commercial harvest for the following fish species was: white bass (32,006 lbs.), channel catfish (260 lbs.), freshwater drum (150 lbs.), bullhead (260 lbs.), buffalo (173 lbs.), and white perch (120 lbs.).

c. Aquatic Macrophytes and Wetlands - With regard to aquatic macrophytes in the general vicinity of Maumee Bay, the final USFWS's Coordination Act Report (1987) stated that during an aerial survey of the Bay and lower Maumee River conducted by the Service in September 1985, the following submergent aquatic beds were observed:

"Seven areas containing small to moderate-sized beds along Maumee Bay shoreline east of the Bayshore Power Plant discharge, a relatively large bed at the mouth of, and just upstream of, Otter Creek, scattered beds northeast of Cullen Park peninsula, large beds in the Cullen Park embayment, and smaller beds in the embayment just upstream of Harrison Marina." The USFWS report also mentions that a representative of the Ohio Environmental Protection Agency "observed aquatic beds in a large embayment on the north side of Maumee River just upstream of the first railway bridge, and along the northwest side of Grassy Island. The aforementioned USFWS report notes that although aquatic beds are not unique to the bay area, "they are part of a habitat type that is relatively scarce in the area". Furthermore, the USFWS indicated that "an examination of lake charts, topographic maps and aerial photography indicates that wetland habitat and shoal habitat are relatively scare in the area. Due to their scarcity and high value to certain evaluation species, these three types of habitat fall within Resource Category 2 as defined in accordance with the U.S. Fish and Wildlife Service's Mitigation Policy, published in the Federal Register on 23 January 1981.

Some information regarding potential species of submergent aquatic plants that may be in the Maumee Bay locale was obtained via personnel telephone communication with a USFWS biologist on 29 January 1993 who had some past experience in the Bay area about seven years ago. The biologist indicated that past observations of such plants around that time consisted of mostly sago pondweed (Potamogeton pectinatus) and curly pondweed (Potamogeton crispus). It is possible that some water clarity improvement that may have occurred in the bay since that time - possibly influenced to some degree by a decrease in some pollutant loadings (i.e., phosphorous) and population by zebra mussels - could have contributed to some increase and/or expansion of aquatic vegetation in the Bay's littoral zone. Some

growth of wild celery (Vallisneria americana) may also be established in the Maumee Bay locale.

With regard to aquatic emergent plants growing in Maumee Bay wetlands, the Maumee River Remedial Action Plan Report (OEPA, 1990) indicates that the major aquatic herbaceous vegetation consists of "narrow-leaf cattail, broad-leaved cattail,jewelweeds, swamp rosemallow, blue joint-grass, and swamp milkweed." The report also states that "in the transition zone between open water and the cattail stands, soft-stem bulrush and three-square bulrush are the dominant species" (Herdendorf, 1987).

A review of U.S. Department of Interior Wetland Inventory Maps entitled Rossford, Ohio; Oregon, Ohio, and Reno Beach, Ohio, prepared by the USFWS Office of Biological Services show approximately 14 wetland classifications in the general vicinity of Maumee Bay and lower portion of the Maumee River. *Table 3* provides a list of wetland classifications found along the coastal zone or open water area of Maumee Bay, and in the lower portion of the Maumee River. The table does not provide specific locations and sizes of the wetlands. For information in this regard, the aforementioned wetland inventory maps can be ordered from the USFWS, National Wetlands Inventory, 9720 Executive Drive, Suite 101, Monroe Building, St. Petersburg, Florida 33702.

Table 3 - Wetlands in the General Vicinity of Maumee Bay and Lower Portion of the Maumee River, Ohio

USDI Wetland Inventory Map Symbol	Classification Description
PSSIY	Palustrine scrub/shrub broad-leaved deciduous vegetation with a saturated, semipermanent seasonal water regime.
PEMY	Palustrine emergents with a saturated, semipermanent, seasonal water regime.
POWHh	Palustrine open water permanent diked area.
PFOIY	Palustrine forested broad-leaved deciduous vegetation with a saturated, semipermanent, seasonal water regime.
PFOIYh	Palustrine forested broad-leaved deciduous vegetation, with a saturated, semipermanent, seasonal water regime, diked.
$P\frac{FOI}{EM}Y$	Palustrine forested broad-leaved deciduous mixed vegetation with emergents, with a saturated semipermanent, seasonal water regime.
$P\frac{SSI}{EM}Y$	Palustrine scrub/shrub broad-leaved deciduous vegetation mixed with palustrine emergent vegetation, with a saturated, semipermanent, seasonal water regime.
$P\frac{FO}{SS}Y$	Palustrine forested vegetation mixed with scrub/shrubs, with a saturated, semipermanent, seasonal water regime.
$\frac{PSS}{EM}$	Palustrine scrub/shrubs with emergents.
L2RSWr	Lacustrine littoral rocky shore that is intermittently flooded (artificial).
L2FLUs	Lacustrine littoral flat spoil area, water regime unknown.
L2FLK	Lacustrine littoral flat artificial wetland area.
R2OWZ	Riverine lower perennial open water, intermittently exposed, permanent wetland.

d. Wildlife - Maumee Bay, and to a lesser extent the Maumee River, provide habitat for a large diversity of waterfowl. The greater number of birds are "divers" such as lesser scaup (Aythya affinis), greater scaup (Aythya marila), common goldeneye (Bucephala clangula), red-breasted merganser (Mergus serrator), American merganser (Mergus merganser), hooded merganser (Lophodytes cucullatus), and ruddy ducks (Oxyura jamaicensis). Dabbling ducks such as mallards (Anas platyrhynchos), black ducks (Anas rubripes), widgeon (Merica sp.), gadwall (Anas strepera), and teal (Anas sp.) are also found but in more limited numbers. The amount and diversity of ducks is dependent upon season and prevailing weather conditions. The bay provides a feeding area representative of shallow water areas in the western basin of Lake Erie. Numerous resting areas are available, depending upon wind direction, in the lee of small islands, such as Grassy Island and the existing CDFs. The "shadows" of these CDFs are especially attractive to fish-eating ducks, gulls, and other birds such as great blue heron (Ardea Herodius), due to the thermal plume from the Toledo Edison Power Plant which attracts fish during cold weather periods (USACE, 1990).

The following limited observations of bird use in the general locale of the new CDF in Maumee Bay were made by the USFWS around 1985. Their observations were as follows:

"Bird use in the site appeared to be rather typical for the shoreline areas of Maumee Bay. Gulls were abundant along the dikes and on the water during all three site visits. Herring gulls appeared to substantially outnumber ring-billed gulls. Two or three great blue herons and about the same number of black-crowned night herons were generally seen on the small peninsula. Occasionally, one or two great egrets would be seen feeding along the peninsula shoreline. A few red-winged blackbirds (Agelaius phoeniceus) were also seen on the peninsula. During the April site visit, two pairs of mallards and one ruddy duck were seen between trap net stations #2 and #3. On 30 July 1985, nine flightless (molting) diving ducks were observed along with four unknown puddle ducks. In the spring and fall, it is likely that the site will be frequented by large numbers of diving ducks, particularly if young gizzard shad are abundant" (USFWS, 1985).

In addition to the herring gull (Larus argentatus), ring-billed gull (Larus delawarensis), great blue heron, black-crowned night heron (Nycticorax nycticorax), ruddy duck, and red-winged blackbird species mentioned previously, a number of other wildlife species probably frequent terrestrial and shoreline habitats in the Maumee Bay - Maumee River vicinity. Such wildlife may include but not be limited to American bittern (Botaurus lentiginosus), Caspian tern (Hydroprogne caspia), common tern (Sterno hirundo), common crow (Corvus branchyrhynchos), a variety of shorebirds and songbirds, hawks, owls, white-tail deer (Odocoileus virginianus), muskrat (Ondathra zibethicus), raccoon (Procyon lotor), squirrel (sciurus Sp.), striped

skunk (Mephitis mephitis), opossum (Didelphis virginiana), and other furbearing species.

e. Threatened and Endangered Species - Maumee Bay and vicinity lies within the range of the American bald eagle (Haliaeetus leucocephalus), which is a Federally-listed endangered species. Since this bird is known to nest at the nearby Ottawa National Wildlife Refuge located in the western basin of Lake Erie, it is possible that it utilizes the shoreline and littoral zone of Maumee Bay as a feeding area (personal communication with the USFWS, Ecological Services Office, Reynoldsburg, Ohio).

2. Environmental Concerns

A review of the Final Environmental Impact Statement (USACE, 1990) on the new CDF at Toledo Harbor, as well as the Maumee River Remedial Action Plan and USACE coordination file identified the following environmental concerns:

- The USFWS expressed concern regarding any loss of wetlands, sago pondweed beds (in vegetated shallows), and shoals (especially those containing significant amounts of sand, gravel, and cobble) in the Maumee Bay locale, since these habitats have high value for certain species of fish and wildlife. The Service categorizes the aforementioned habitats as being in Resource Category 2 - whereby the goal regarding habitats in this category is "no-net loss of in-kind-habitat value. The USFWS's Final Fish and Wildlife Coordination Act Report (1987) further indicates that creation of artificial reefs as mitigation may satisfy the goal for Resource Category 2 habitats under the Exceptions Clause. Any potential mitigation measures should be coordinated with the USFWS Ecological Services Office located at Reynoldsburg, Ohio. The Ohio Department of Natural Resources (ODNR) concurs with the USFWS that mitigation measures should be required to compensate for loss of fish and wildlife resources resulting from construction of a project in the bay.

- Since the shallow waters of Maumee Bay provide important spawning and nursery habitats for both forage and game species of fish, as well as feeding habitat for aquatic birds, any alteration of such habitat that may significantly alter or stress the aquatic ecosystem, would be of important concern to Federal, State, and local interests. Also, water quality certification for any fill material or dredged material discharges into the Bay or Maumee River would be required from OEPA under Section 401 of the Clean Water Act.

o Concern has been expressed by the USFWS, ODNR, and the public in regard to botulism problems that have been experienced in the past at existing CDF sites in the general vicinity of Toledo. Improper water management at such CDF can result in significant waterfowl mortality, and mortality to endangered species such as bald eagles- that may feed on botulism stricken waterfowl. Formulation of an annual long-term management plan to terminate botulism outbreaks at CDF was recommended for future consideration (ODNR, 1984).

o Concern has been expressed that not enough effort has been given to finding beneficial uses of material presently contained in the existing CDFs, in order to extend the useful life of these CDFs. The Toledo-Lucas County Authority (1984) expressed favor towards a re-use of dredged material, in order to minimize construction of disposal areas. Since 1986, the Port Authority has been working with a private contractor on the development of a recycled material using a large percentage of dredged material.

o Concern has been expressed regarding the use of dredged sediments to create or enhance wetlands. Such sediments are suspected of containing elevated levels of heavy metals (i.e., mercury, etc.), which "may be readily available for bioaccumulation to potentially harmful levels" (USEPA, 1980). However, whenever possible, use of uncontaminated dredged material to create or enhance wetlands should be considered. Such beneficial use, where appropriate, could help fulfill the USFWS's North American Waterfowl Management Plan goals to improve or create needed wetlands for production of waterfowl and other aquatic organisms that are dependent on this significant habitat resource.

o The Maumee River Remedial Action Plan (Toledo Metropolitan Council of Governments, 1991) specifies that the "goal is fishable and swimmable waters with zero discharge of persistent toxic pollutants." As indicated in the aforementioned plan, the Great Lakes Water Quality Agreement (originally signed in 1972, but revised and signed again in 1978) is concerned with beneficial uses impairment that could alter the chemical, physical, or biological integrity of the Great Lakes ecosystem sufficiently enough to cause loss of fish and wildlife habitat, degradation of benthos, phytoplankton, zooplankton, and fish and wildlife populations, or changes such a aesthetic degradation, fish tumors, fish and wildlife deformities, and other adverse impacts on such organisms in the environment.

o Organic Contamination - OEPA, USEPA and USACE have concurred that concentrations of organic contaminants, mainly PAHs generally between 1 and 3 ppm in the River Channel sediments, have precluded their acceptability for unrestricted open-lake discharge. Higher levels of some Phthalate Esters detected in some River Channel sediments support of this determination. Concerns expressed over these factors, as well as elevated levels of some inorganic parameters, lead to the decision to contain all channel sediments riverward of Lake Mile 2 into a CDF.

o OEPA has expressed concerns relative to the release of contaminants from resuspended sediments during the open-lake discharge of Toledo Harbor Lake Approach Channel dredged sediments (i.e., those lakeward of Lake Mile 2) in the Western Basin of Erie. This view was formulated due to the predominant shallow depths in the Western Basin and its erosive nature, which are conducive to frequent sediment resuspension.

o Concern has been expressed that the discharge of phosphorus-contaminated sediments in the Western Basin of Lake Erie increases the eutrophication process, and is therefore counter to the intent of the Great Lakes Phosphorus Reduction Control Strategy and Great Lakes Water Quality Agreements. Sediments discharged in the Western Basin are resuspended and release phosphorus, making it available for uptake by aquatic biota. This may increase algal productivity and a decrease in dissolved oxygen levels. Existing bulk sediment chemistry data show that phosporus levels in Lake Approach Channel sediments are within the "Heavily Polluted" category of the 1977 USEPA, Region 5 Guidelines for the Pollutional Classification of Great Lakes Harbor Sediments (greater than 650 ppm). However, elutriate test data do not evidence any significant releases of phosphorus from the sediments. Phosphorus availability (De Pinto) testing showed a low availability of phosphorus.

o In general, concern has been expressed by Federal and State environmental interests regarding potential impacts of construction work on fisheries activities - primarily warmwater fish (walleye, yellow perch, and blackbass), and movement of possibly some salmonids in the Maumee River/Maumee Bay area. Coordination with the U.S. Fish and Wildlife Service, as well as with the Ohio Department of Natural Resources resulted in an "environmental window" recommendation that, construction work be performed between 15 June and 15 September in order to help minimize adverse impacts on these resources.

H. NEW TESTING EVALUATION PROCEDURES

In 1992, the Planning Group, in its effort to develop a Long-Term Dredged Material Management Plan for Toledo Harbor within the context of the Sediment Management Strategy for the Maumee River Watershed, reached agreement with the Ohio Environmental Protection Agency to continue maintenance of the Port of Toledo in 1993 and 1994, **pursuant to current testing evaluation procedures** established in Section 404 and 401 of the Clean Water Act.

In 1990, the U.S. Environmental Protection Agency (USEPA), Region 5, and the U.S. Army Corps of Engineers, with support from the EPA Environmental Research Laboratory at Duluth, Minnesota, and US Army Engineer Waterways Experiment Station at Vicksburg, Mississippi, has formed an inter-agency task group that is

currently in the process of developing a new regional manual referred to as **"Great Lakes Dredged Material Testing & Evaluation Manual"** on dredged material disposal in the Great Lakes under Section 404(b)(1) of the Clean Water Act.

The USEPA and USACE are currently working on a new National Guidance Manual to be called the "Inland Testing Manual." It is the intent that this manual will provide guidance for determining the appropriate method(s) of disposal for dredged material/sediment. Since the national Manual will be general in nature and will lack some of the specifics needed for regional implementation, the regional manual (being developed) will help guide the testing of the dredged material and evaluation in compliance with the national manual.

The national testing manual is currently scheduled for public review and comment in the Spring or Summer 1993. It is anticipated that the national and regional manuals will be ready for public review and comment at the same time. When the regional manual is distributed for agency and public review, the USEPA and USACE will provide additional briefings for State regulatory agencies on implementation of the manual.

Currently, the USACE Waterways Experiment Station (WES) is preparing interpretative guidance for the biological testing. Trial basis testing is being performed on Toledo Harbor sediments from the areas identified in *Figure 19*.

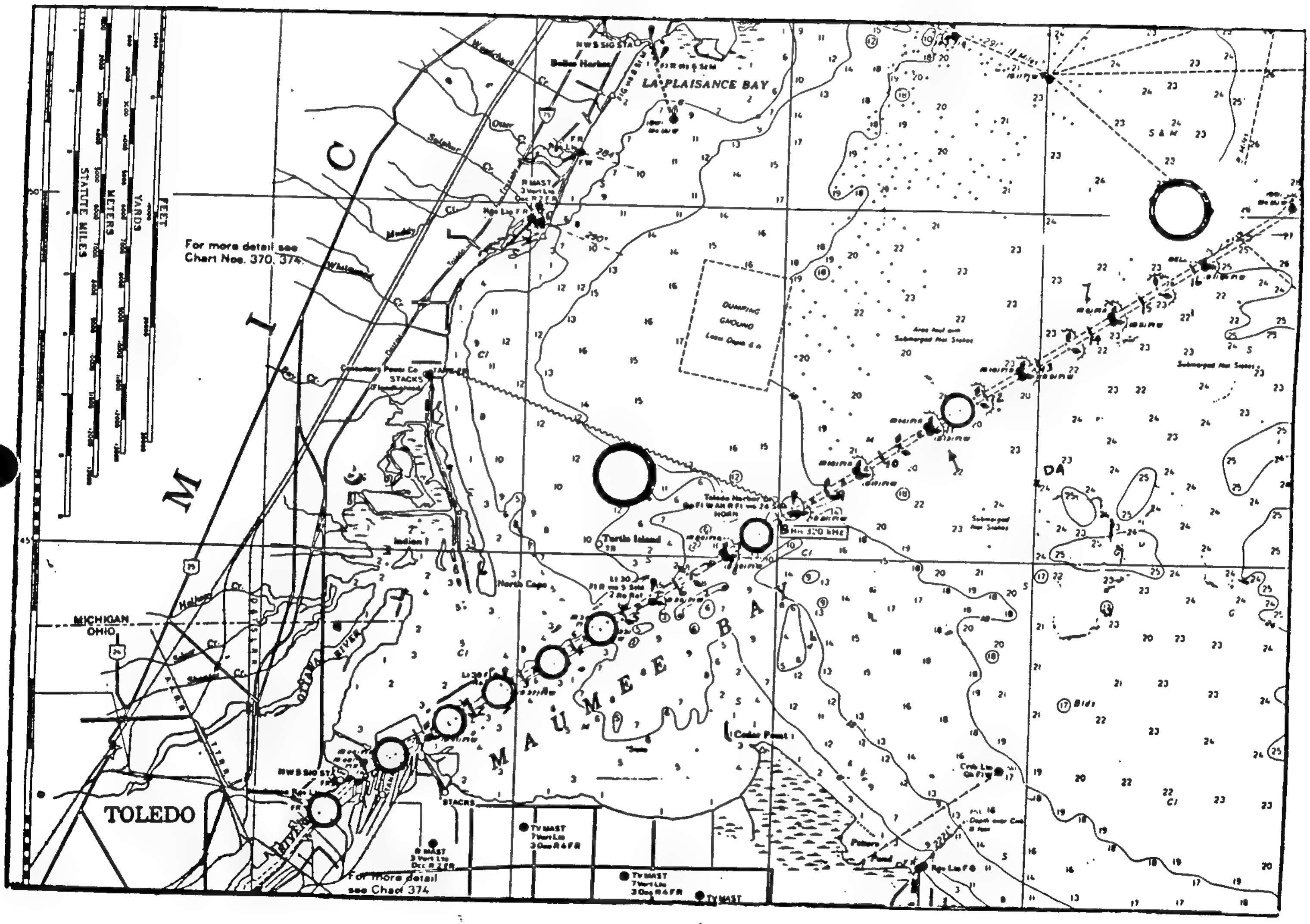


Figure 19 - Toledo Harbor Biological Testing Areas

IV. MANAGEMENT OPTIONS

(Definition and Discussion of Considered Options)

A. SEDIMENT LOAD REDUCTION

1. Erosion Reduction Methods

The Remedial Action Plan (RAP) for the Maumee River Area of Concern discussed soil erosion in the watershed associated with the Maumee River and recommended a number of potential controls that could reduce soil erosion and the quantity of sediment that ends up in the river and subsequently in the ship channel (OEPA, 1990 and TMACOG, 1991). These controls included conservation tillage, No-Till planting, conservation cover crops, conservation cropping sequence, critical area planting, field windbreak, filter strips, grassed waterway, and streambank protection. Each of these controls has been considered for implementation in the watershed. While all will reduce soil erosion and sedimentation in the river, certain controls appear to have more potential for reducing large quantities of sediment than others. These include conservation tillage, No-Till planting, filter strips, grassed waterways, streambank protection and sedimentation ponds and/or agricultural runoff retention reservoir, currently in early stages of development by the Maumee Valley Resource Conservation and Development. Each will be discussed in more detail below.

Over 90 percent of the erosion occurring in the basin occurs as a result of crop production (USDA,SCS 1993). An additional 3 to 4 percent comes from gully and large rill erosion and the rest comes from all other sources. Therefore, the obvious place to begin an analysis of erosion reduction is in the cropland area. Seventy-five percent of the cropland acreage (about 2.5 million acres) is planted to corn and soybeans each year.

There are two broad categories of erosion control, one is through change in annual management **(Non-Structural Practices)** and the other is the installation of permanent **"Structural Practices."**

<u>a. Non-Structural Measures</u> - Management practices for erosion control fall into two subcategories, crop residue management and conservation cropping sequence.

(1) Crop Residue Management - Crop residue management consists of a

management system where the farmer reduces the amount of annual tillage to the point where a specific amount of crop residue (30 to 100 percent of the soil surface covered with the previous crop residue after planting) covers the soil surface from harvest through the planting of the next crop. This usually requires specialized, but not scarce, equipment.

(a) *No-Till* planting means the soil is not tilled from the time of the harvest of the previous crop until the planting of the following crop. Further evaluation of this alternative is warranted.

(b) *Conservation Tillage* means that the soil is tilled after harvest, but is tilled in such a manner that at least 30 percent of the soil surface is covered with the previous crop residue after planting. A hypothetical example of the sediment reduction that potentially could result from the conversion of 80% of the corn and soybean areas to conservation tillage is described in *Appendix C.* This type of control will result in an estimated reduction of sediment reaching the harbor of 146,000 cubic yards. This is an equivalent of 18% of the annual sediment requiring dredging. To save this 146,000 cubic yards of dredging per year would require that 80 percent of the corn and soybean acreage to be in a crop residue management system. Further evaluation of this alternative is warranted.

(2) Conservation Cropping Sequence - Conservation cropping sequence is the addition or substitution of certain types of crops in a rotation such as hay and small grains that are less conductive to erosion than corn and soybeans. These crops are desirable because the plant spacings are very close and the soil surface is protected more quickly than corn or soybeans.

(a) *Hay* - Hay is an environmentally friendly crop, but there are problems in increasing acreage of this crop. The problems are perception, market, and government programs. The perception is that hay is not a money making crop and is far too labor intensive to grow. There is no set price or local delivery locations as there are for corn and soybeans. Also, hay is not a commodity so there is no government subsidy. One advantage is that each acre converted to hay produces the same amount of erosion as two acres of crop residue management because of superior erosion protection. To reduce 146,000 cubic yards of sediment in the harbor would require the conversion of 500,000 acres of cropland from corn and soybeans to hay. This is highly unlikely in the short term, but in the long term some additional acres could be converted. A study of the impacts of this crop and additional markets is warranted for long range study.

(b) *Small Grains - Wheat and Oats*

i) Oats - While the demand for oat products remains high, most of the oats for human consumption are imported. There are no government subsidies for oats and the average price is around $1.40 per bushel. With yields averaging 50 to 70 bushels per acre, gross returns are only $70 to $100 per acre. This barely covers the cost of land rental payments. <u>No further action is warranted at this time.</u>

ii) Wheat - Wheat is a subsidized crop and acreage limitations are imposed yearly on this commodity crop. Significant increases in acreage are unlikely because those individuals who increase wheat acres more than their allotment would be ineligible for all government crop subsidies. Without these dollars being replaced from some other source, this is not going to happen. <u>No further action is warranted at this time.</u>

(3) Alternative Crops - At least one alternative crop - canola - appears to have a chance at increasing acreage with additional assistance. Canola provides an excellent winter cover and would be beneficial to erosion reductions in the basin if included in the basin if included in the rotation. It is usually substituted for soybeans. Limitations are one of scale and market. The market infrastructure will not gear up to handle canola because it requires separate bins and management and the farmer will not raise it because there is no local market to deliver it to and obtain the same pricing service that they get from corn and soybeans. <u>Study of this alternative crop is warranted in the long range.</u>

<u>b. Structural Measures</u> - Structural practices are those erosion reduction efforts that last more than a year, usually 10 to 20 years with maintenance, and provide a accumulated erosion savings over time. They usually require off-farm assistance for design and installation. In the basin, these would be filter strips, grass waterways, streambank protection, and wetland/sedimentation basins.

(1) Filter Strips are strips or areas of vegetation established for removing sediment and other pollutants from runoff of wastewater by filtration, deposition, infiltration, absorption, adsorption, decomposition and volatilization, thereby reducing pollution of the environment (TMACOG, 1991). The RAP recommended the establishment of 10 foot grass filter strips on both sides of all intermittent streams in the watershed; a 66 to 99 foot, one side forested, one side

grass buffer/filter strip on all perennial rivers or streams; and a 120 foot forested buffer/filter strip on designated Scenic Rivers.

Design requires laminar flow over a sufficient width of vegetation to be effective. Rarely do these conditions exist. Storms larger than a 2 to 3 year rainfall result in concentrated flow through the filter strip and carry sediment and other material directly into the stream. The strips, if properly designed and installed, would filter out a large percentage of the sand and silt particles. However, this is not the material that reaches the harbor which is predominantly fine silts and clays. In the absence of filter strips, most of the sands and silts are being deposited in the extensive drainage system that exists in the basin. Filter strips would reduce the cost of local drainage maintenance, but would not reduce volumes at the harbor significantly except for the reduction of erosion caused by the conversion of cropland to permanent vegetative cover. However, this would be minor when compared to the total remaining erosion.

To be effective, filter strips would have to be wider than is commonly accepted by the farm manager. Filter strips of the width required to remove clay particles would have to be 100 to 150 feet wide and preferably planted to trees. No further action is warranted.

(2) Grassed Waterway - is the establishment of a channel with adequate capacity and suitable vegetation to convey runoff without causing erosion of flooding and improving water quality (TMACOG, 1991). Ditches at the end of agricultural fields could be widened to reduce side slopes and grassed from one side to the other. This will spread runoff water in a thinner layer across the widened ditch and allow the grass to filter runoff water as it moves through the ditch.

Grassed waterways eliminate the erosion caused by concentrated flow of water. A detailed inventory of the amount of grassed waterways needed in the basin has not been done. Almost all of the grass waterways installed in the basin are designed to eliminate erosion occurring in gullies that are 6 inches to 3 feet deep that occur on cropland that has a slope of 2 percent or greater. The average length is 800 to 1000 feet long and causes about 15 tons of soil loss per year. About one grassed waterway is needed for every 30 acres of cropland with slope greater than 2 percent. From the 1982 National Resource Inventory, there are 440,000 acres of cropland with slopes above 2 percent. Dividing this by 30 acres per waterway results in 14,700 waterways. About half or more already have been installed. This leaves 7,300. Many of these will be installed as the result of the 1990 Farm Bill (FACTA) which requires concentrated flow erosion to be controlled by 1995 or lose government subsidies. Additional technical assistance is warranted at this time.

(3) Streambank Erosion Control - was recommended in the RAP (OEPA, 1990). Streambank erosion was estimated in the Maumee Level B Study at 100,000 tons a year. This is 1 percent of the total erosion occurring in the basin. Streambank erosion is dramatic when it occurs, but the relative low velocities of the streams and the flat topography keep the figures insignificant. Most streambank erosion is currently being solved with expensive regrading and rip rap. Unless lower cost solutions can be found to control this type of erosion, the cost per ton saved is too excessive. <u>No further action is warranted.</u>

(4) Creation of Wetlands/Sedimentation Ponds can filter suspended solids and eroded soil and reduce the quantities of sediment that end up in rivers or harbors. Created wetlands could take the form of a vegetated sedimentation pond at the end or corner of an agricultural field that filters and removes suspended solids and eroded soil particles from runoff water prior to release to a stream or river.

Wetland/sediment basins are relatively unknown. Research reveals the potential to filter out sediments as well as contaminants. A large number of these (perhaps one every 40 acres) would have to be built before it is anticipated that significant sediment reduction could occur. However, if these are coupled with some type of crop irrigation scheme and an investment return from wildlife can be obtained, their viability is enhanced.

Another similar concept " *Agricultural Runoff Retention Reservoirs*, under consideration by the Maumee Valley Resource Conservation and Development (RC&D) can capture and retain surface runoff from agricultural cropland (Czartoski, 1992). These structures are similar to storm water retention basins commonly used along highways to capture and retain runoff, so that suspended solids can settle out along with highway contaminants prior to runoff water reaching a stream or lake. The proposed demonstration of the construction and use of such structures will enhance the understanding of how well these structures function. <u>A study to determine the feasibility of this type of approach is warranted.</u>

B.CONTAMINANT LEVEL REDUCTION

1. Nutrient Management

The Maumee River RAP discussed the problems associated with excessive levels of nitrogen and phosphorus measured in the river (OEPA, 1990). Sources of large amounts of nitrogen and phosphorus were identified from the agricultural use of fertilizers. The RAP recommended that the amount, form, placement, and timing of

applications of plant nutrients should be managed in a manner that minimizes the entry of such nutrients into surface and groundwater, and maintains or improves the chemical and biological condition of the soil. To accomplish this, it was further recommended that any land having a Bray P-1 phosphorus level in excess of 60 pounds per acre for row crop and small grain rotation and 90 pounds per acre for specialty crop and forages in a rotation of available phosphorus should have no additional phosphorus fertilizer applied until soil test levels are reduced below this level by crop removal (TMACOG, 1991). Soil testing is the key to nutrient management. The RAP recommended all soils be tested at least every three years, or more often, depending on the crop. Procedures are available from the Ohio Cooperative Extension Service.

Implementation of nutrient management as described above should reduce nitrogen as nitrate in the river and should eliminate potential problems of nitrate in drinking water at those communities that use the river as a source of drinking water. In addition, nutrient management and a reduction of phosphorus will reduce the amount of nutrients discharged into Lake Erie, and thereby improving the water quality of the Lake. <u>Further evaluation of the implementation of nutrient management is warranted.</u>

2. Waste Management

The RAP also recommended that waste generated by agricultural production or processing should be managed in a manner that prevents or minimizes degradation of air, soil and water resources (TMACOG, 1991). Soil Conservation Service standard and specifications on animal waste management were recommended. The RAP also recommended that a waste management plan be developed indicating the need for soil testing at least every three years and annual manure testing. <u>Further evaluation of the extent of the implementation of SCS standards and specifications on animal waste management and the potential for reduction of animal waste constituents in the Maumee River is warranted.</u>

3. Pest Management

The RAP recommended that agricultural pest infestation should be managed to reduce adverse effects on plant growth but be environmentally acceptable (TMACOG, 1991). The principles of an Integrated Pest Management (IMP) program should be applied when managing pest infestations. While these principles continue to need to be applied, a review of existing sediment data for Toledo Harbor has indicated concentrations of pesticides are generally below analytical detection limits. <u>No further evaluation is warranted at this time.</u>

C. BENEFICIAL USE

Dredged material can be reconditioned for use in a beneficial manner. The important issue is to know what the characteristics of the dredged material are before it is placed or used for a beneficial purpose. Once the dredged material characteristics are known, plan can be wisely formulated to achieve benefits from this reusable resource. Appropriate management of dredged material can lead to successful reuse benefits to the project and the community. There has been some preliminary development of the beneficial uses of Toledo Harbor dredged material (TMACOG, 1990). An example is the production of NU-soil from dewatered dredged material at the Confined Disposal Facility (Port Authority CDF #3). This and other potential uses of dredged material will be identified and discussed in this section of the Phase 1 report. Each potential use will need further evaluation and quantification.

1. Manufactured Soils

The Corps Dredged Material Research Program (DMRP) in 1977 showed that dredged material could be used to improve marginal agricultural soils (Gupta et al., 1977) and in some cases was ideal for vegetable production in truck farming. From South Carolina to Oregon, sandy textured dredged material has been successfully used to produce vegetables. In 1985, a study of the use of Toledo Harbor dredged material as topsoil for golf course construction revealed that some of the dredged material can be used to help grow grass on golf courses with the addition of nutrients and organic matter (Danneberger, 1985).

<u>a. Nu-Soil</u> - At this same time, a manufactured soil under the trademark of Nu-Soil was being developed and demonstrated. Nu-Soil is a topsoil product produced a local company. It consists of 90% dewatered dredged material, 8% wastewater biosolids, and 2% water treatment lime sludge *(See Appendix D)*. Successful demonstrations of Nu-Soil, dredged material alone, and dredged material mixed with native topsoil for growing turf grasses have been reported (Danneberger, 1985). Nu-Soil has a pH of around 8 from the lime addition, and can be used as a topsoil product. It contains a large fraction of silt and clay from the dredged material, and an increased organic matter and nutrient level from the addition of wastewater biosolids. The conditioning of the wastewater biosolids determines whether the NU-soil meets the "Class A" pathogen reduction standards according to the USEPA sludge regulations. Nu-Soil is less expensive than conventional topsoil, thus should be sustainable through the sale of the product as topsoil. The market for this product has been developing and has shown much success as landfill cover. <u>Further evaluation of the productive use of Toledo Harbor dredged material as NU-soil is warranted.</u>

(1) Landfill Cover Preliminary estimates of the need or potential use of Toledo Harbor dredged material and/or Nu-soil for landfill daily cover are 200,000 to 800,000 cu. yd. at the Dura Landfill and up to 4,000 cu. yd. for demonstrating its use at the Hoffman Road Landfill (TMACOG, 1990). In addition, King Road Landfill will require about 230,000 cu yd of clay, and 60,000 cu. yd. of cover in or about 1993. Another potential use of Nu-soil as capping material was identified at Envirosafe; however, quantities need to be estimated.

(2) Ball Fields and Golf Courses - Use of Nu-soil for topsoil on ball fields and city golf courses has been suggested (TMACOG, 1990). The quantities required and time frame for these uses need to be estimated.

(3) Recreational Hill - A suggested use for Toledo Harbor dredged material and Nu-soil is construction of a recreational hill at a location in Erie County, Michigan. The ultimate acceptability of this alternative to the local public needs to be determined. Should this be a viable alternative, additional testing will be required to determine the structural requirements and potential conditioning of dredged material to allow such an undertaking.

(4) Topsoil Cover - Another potential use of NU-soil as topsoil has been suggested at Buckeye Basin in about 1993 or so. The potential for this use needs to be revisited and the quantities required estimated.

(5) Landscaping - There appears to be a potential use of Nu-soil in Front Street Improvements in East Toledo (TMACOG, 1990). The market for this potential needs to be pursued and the quantities estimated. Another potential use of Nu-soil has been suggested for the Millard Avenue project, another street improvement project in Toledo (TMACOG, 1990). The quantities need to be estimated. Likewise, the potential use of NU-soil for ODOT Road Improvement Projects, such as Harroun Road, Wales Road and Interstate 75, needs to be evaluated and quantified. This will require the testing of Nu-Soil to conform to ODOT Specification No. 653, which sets the standards for topsoil composition and handling. Should Nu-Soil pass these test criteria, the cost savings of $3.50/cu. yd. should make Nu-Soil very attractive for contractors (TMACOG, 1990).

b. N-Viro - Another productive use of dredged material as an amended soil material called N-Viro has been developed and is available for mixing with dredged material to improve the nutritive quality of dredged material for use as topsoil. The N-Viro Soil Process uses a combination of microbiological stresses to avhieve vitually complete pathogen destruction, and has been certified by U.S.EPA as a process to further reduce pathogens. N-Viro is produced by blending wastewater treatment sewage sludge and cement-kiln dust under this patented process. The use of

the cement Kiln Dust, an alkaline by-product of the cement industry, is to achieve alkaline pH(>12), rapid drying, and temperature rise. The final product is a solid, granular, odor-free material with many of the desirable properties of soil. This gives N-Viro great flexibility in terms of its beneficial use.

There appears to be three major uses of the N-Viro Soil Product to date. These are first, as a soil supplement for agriculture, second; as a daily cover in landfill operations; and third, as a reclamation additive for strip mine spoils. Agronomic studies of N-Viro have shown that application of to corn and soybean fields has a positive value for these crops (Terry Logan, 1992). Some increase in productivity was observed for the higher application rates and this was at least patly attrbuted to the organic nature of the N-Viro Soil product protecting the crop against drought and heat conditions. The characteristics of the N-Viro Soil product include those of: a) a fertilizer with approximately 1% Nitogen, Phosphorus and Potassium value; b) aglime equivalency of between 25 and 60%; and c) a soil conditioner with a high organic content.

N-Viro meets EPA criteria as a safe reusable soil product that is nutrient and organic matter rich and has sufficient lime content to be used as a liming material to raise soil pH when added to soil. Blending N-Viro and dredged material can potentially produce a soil material that can be used as topsoil in many of the above potential alternatives. An additional use of N-Viro amended dredged material might be as a soil material for wetland creation. <u>Further evaluation of N-Viro as a dredged material amendment is warranted.</u>

D. ENVIRONMENTAL RESTORATION

Dredged material can be used for environmental restoration such as reconstructing eroding shoreline, islands, peninsulas, and creation of wetlands and wildlife habitat. This section will discuss the potential use of suitable Toledo Harbor dredged sediment for environmental restoration projects.

1. Woodtick Peninsula

The restoration of Woodtick Peninsula would be a significant beneficial use of dredged material from Toledo Harbor. An estimated 6 million cubic yards of dredged material would be required (TMACOG 1989). This potential needs to be more carefully pursued, especially as a phased project, where dredging from each year can be placed in a compartment of the restoration. In this way the project will eventually be completed over a number of years. The use of underwater berms or geotechnical

tubes filled with acceptable dredged material needs to be further evaluated *(Figure 20)*. Such a use of dredged material-filled geotubes has had good success for shoreline erosion control in estuary and coastal environment (Sprague 1993). This potential use of Toledo dredged material will definitely extend the long term use of existing CDFs and can provide substantial wetland areas for this part of Lake Erie. Further evaluation of this alternative option is warranted.

2. Productive Use of Grassy Island CDF

There appears to be some interest in developing the Grassy Island CDF into a wildlife habitat area or recycling facility. Contouring, and the creation/enhancement of wetlands within the site, would increase and diversify the use of the site by waterfowl. Additional evaluation of the quality of dredged material in the CDF, possible cover with lesser polluted material and the potential for managing the dredged material to eliminate or minimize contaminant migration within the CDF, is needed. Limited sampling of the dredged material has occurred (Aqua Tech, 1984, 1985). These data show some degree of PAH and PCB contamination. Appropriate management of the CDF to minimize potential for contaminant problems is required. The site presently has a mound of coarse textured dredged material in the center. Further evaluation of this alternative is warranted.

3. Development of Existing Port facility #3 for Recreation.

Development of CDF# 3 has been suggested by TMACOG, 1990, in the form of raising the dikes and filling to a higher elevation, by moving and contouring dewatered dredged material into a hill or hills and landscaping them, or a combination of raising the dikes and contouring. Such a development could use large quantities of dredged material, but would require rezoning and the loss of the CDF for future dredged material disposal use. Further evaluation of this alternative is warranted.

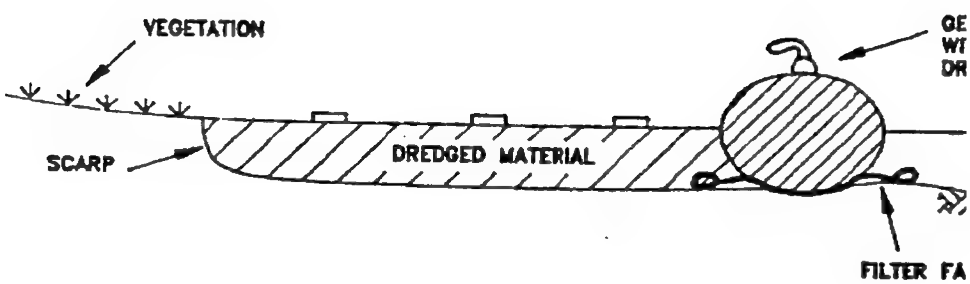


Figure 20 - Dredged Material - Filled Geotubes

4. Development of shallow water habitat

During the consideration of mitigation measures for the construction of the new CDF at Toledo Harbor, interest was expressed for the development of shallow water habitat *(Figure 21, Figure 22, and Figure 23)* (TCDP, 1990). Specific areas within Maumee Bay were identified for the creation of shallow water habitat, specially along breakwater structures on the north side of grassy Island. Underwater berms and/or riprap could be used to protect these shallow water habitats during storms and from wave action. Use of dredged material-filled geotechnical fabric tubes can enhance shallow water habitat as shown in Figure 24. Suitable (acceptable) dredged material from Toledo Harbor could be used to increase the area of shallow water habitat. Given that waterfowl quickly concentrate contaminants in their body tissues when subjected to prolonged exposure in CDF (USFWS), in the development of this option, the uptake of contaminants into the food chain must be given serious and careful consideration. Further evaluation of this option is warranted.

E. CONFINED DISPOSAL

1. Conventional Use of Existing CDFs. The volumetric capacities of existing CDFs (including the Toledo CDF #2 now under construction) are summarized in Section III, Paragraph D of this report. It can be assumed that some portion of the Maumee River sediments would be found to be unsuitable for open water disposal in the future using the new assessment procedures, and this material would be placed in CDFs. The conventional use of CDFs refers to placement of material in the sites with no special management for dewatering to increase the long-term storage capacity. Without specific settling and consolidation laboratory test data on the sediments, the volume occupied by material hydraulically placed in the CDFs can only be estimated. For purposes of describing options in this Phase 1 Report, it is assumed that the volume occupied in the CDF after initial settling and consolidation is equal to that occupied in the channel prior to dredging.

The total remaining capacity of all existing CDFs is approximately 9,995,000 cubic yards (See Section 3, item E(1)(a,b,c), Available Resources). Assessing an extreme case of no volume change and no further lake disposal after 1994, the full 900,000 cubic yard per year requirement would go to the CDFs, and the capacity of the sites would be exhausted in about ten years. It is obvious that some combination of CDF management, upgrading and construction of new CDFs, beneficial uses, sediment volume reduction and continuation of open-lake disposal for acceptable sediments may be required to maintain the project in the long term.

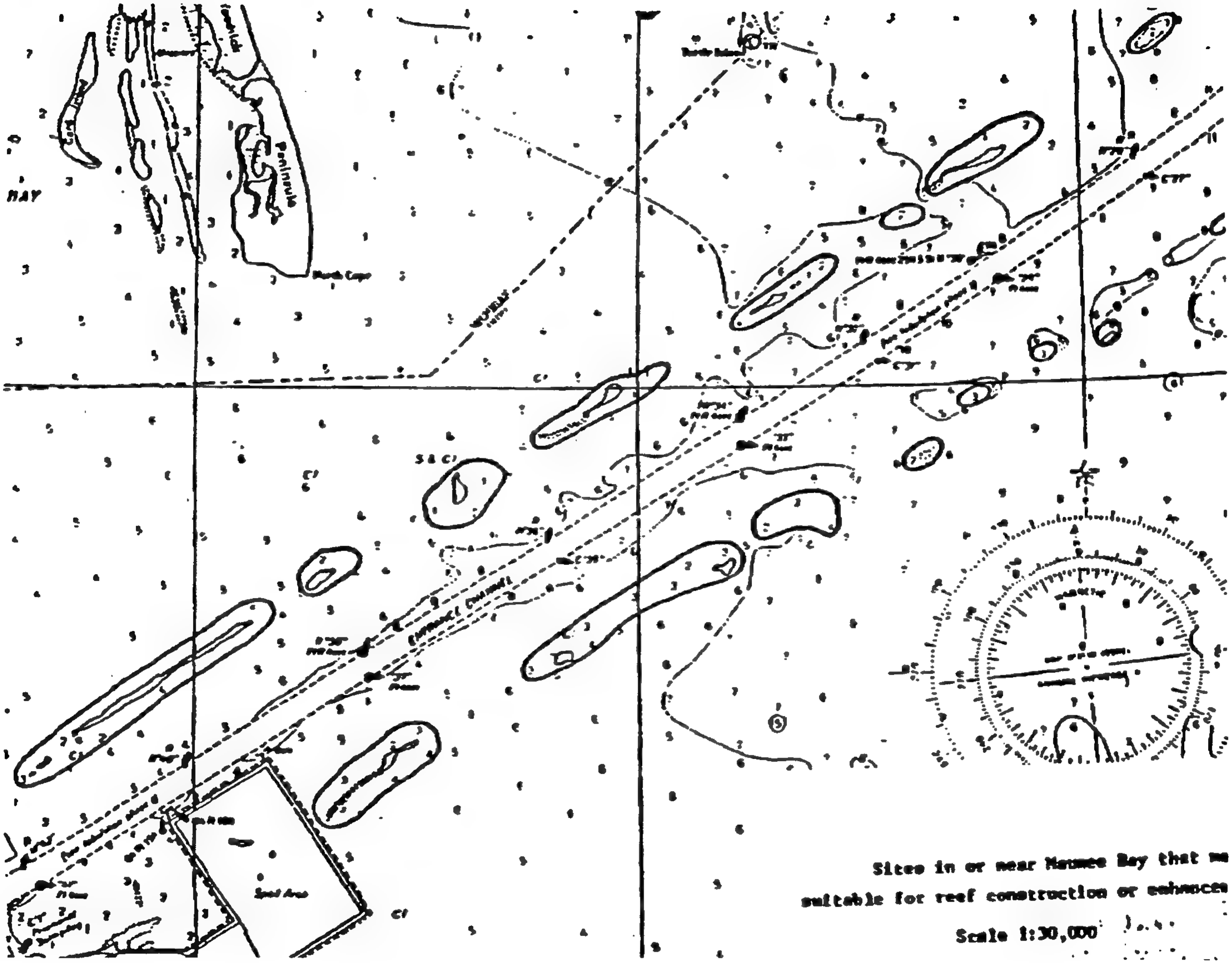


Figure 21 - Sites Suitable for Reef and Water Habitat

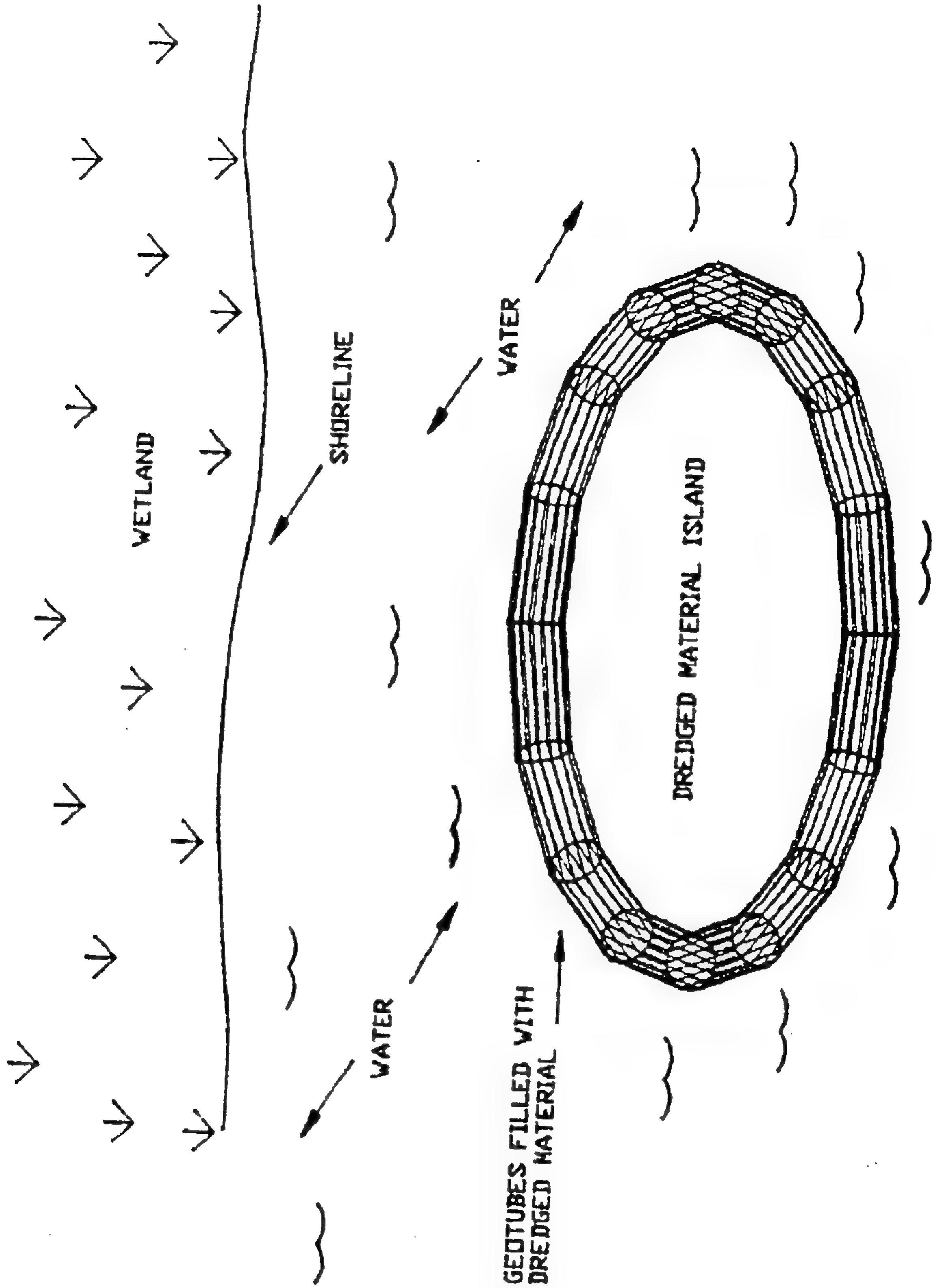


Figure 22 - *Shallow Water Habitat*

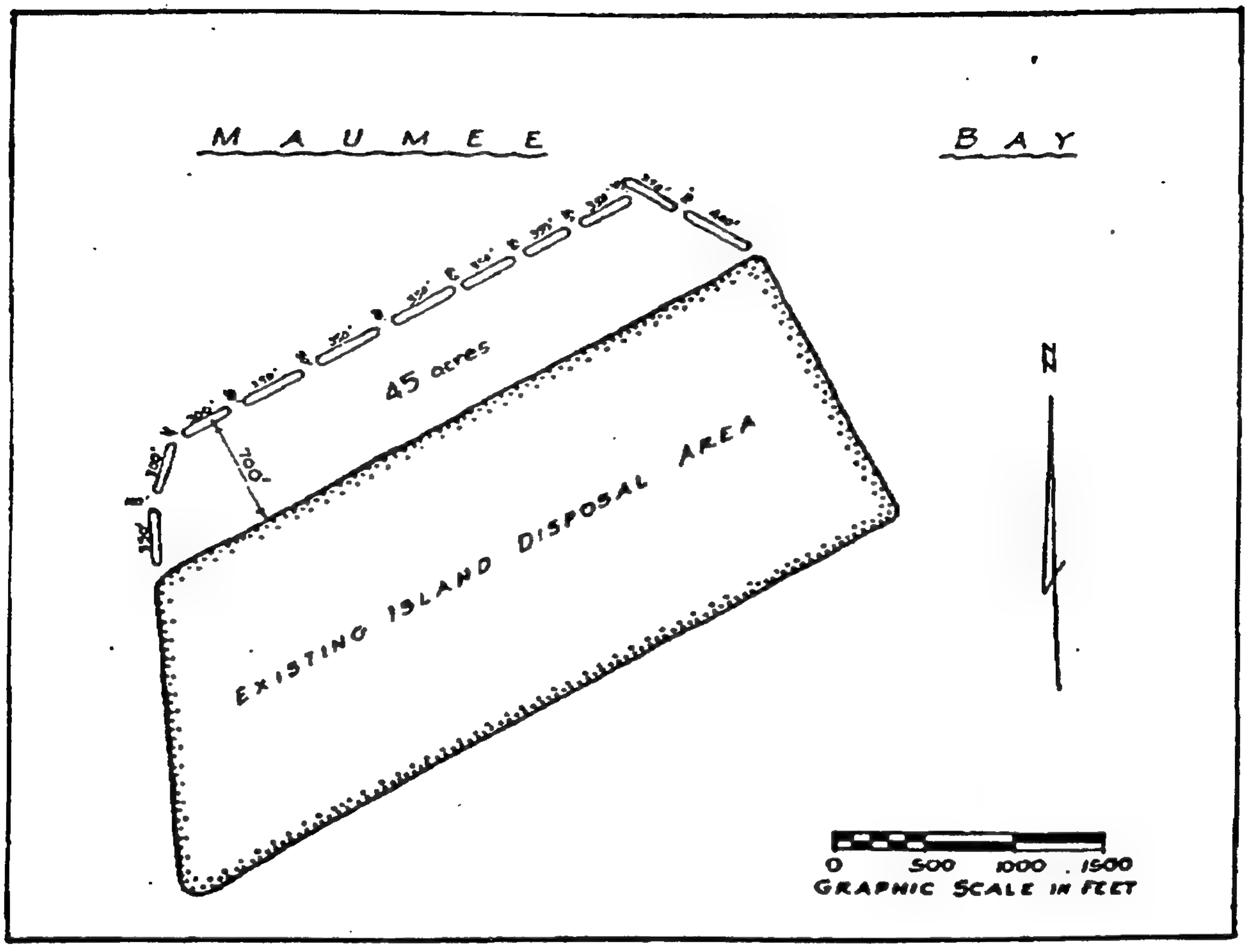


Figure 23 - Island 18 Breakwater

2. Upgrading Existing CDF Dike Elevations - The Toledo CDFs #1 and #2 have dike elevations of +23.5 feet LWD. There is concern over aesthetics associated with future increases in dike elevation, but these concerns must be weighed against the project requirements for additional disposal capacity. Raising the dike elevation of CDFs is a common approach to increasing storage (Palermo 1980). Incremental dike elevation increases of five feet could be easily accomplished with use of dewatered dredged material. The slope stability of the dike cross-section should be evaluated to determine the limits of dike elevation due to stability considerations. Benching incremental dike upgrades aid in a more stable configuration. Provisions for planting the outside dike slopes and benches can offset some of the aesthetic concerns and can provide valuable habitat.

3. Management of CDFs for Maximum Storage - If a CDF is well-managed following active filling, the excess water will drain from the surface and natural evaporation will act to dewater the material. However, active dewatering operations should be considered to speed up the dewatering process and achieve the maximum possible volume reduction, considering the site-specific conditions and operational constraints.

A number of dewatering techniques for fine-grained dredged material have been studied; however, surface trenching and use of underdrains were found to be the only technically feasible and economically justifiable dewatering techniques (Haliburton, 1978). Guidance for application of underdrains is available (Hammer, 1981), and the use of underdrains has been successfully applied in CDFs. However, use of underdrains over large surface areas is not as economical as surface drainage techniques and have not been routinely applied.

The concept of surface trenching to dewater fine-grained dredged material was first applied by the Dutch (d'Angremond et al, 1978), and later field-verified under conditions typical of CDFs in the U.S. (Palermo, 1977). Surface trenching has since become a commonly used management approach for dewatering CDFs (Poindexter, 1988, Poindexter-Rollings, 1989). The approach normally involves development of trenches adjacent to the retaining dikes around the periphery of the CDF followed by development of interior trenches over the entire CDF surface area. Conventional equipment, such as draglines and backhoes, are normally used for the periphery trenches, and trenching machines mounted on low-ground-pressure carriers are normally used for the interior trenches (USACE, 1987; and Palermo, 1992).

For the Toledo CDFs, the dewatering operations could be carried out initially in the eastern portion of the Toledo CDF #1 site. Once 1994 operations are completed, the dewatering could be extended in the western portion. Dewatering could not be initiated in the Toledo CDF #2 site until the fill elevation is above lake level.

4. CDF Reuse Management - A Reusable CDF (RCDF) is one in which all or part of the dredged material is removed to restore storage capacity of the site (Montgomery et al, 1978). A RCDF can therefore be thought of as a transfer station, where dredged material is collected, processed if necessary, and removed for beneficial use or disposal elsewhere. RCDFs in which only a portion of the total volume of material is removed will have extended service lives as compared to CDFs which are used conventionally or with management for dewatering. Removal of material from the CDF for use in upgrading dike systems on site, or for beneficial uses offsite are the most common approaches.

Another option that warrants further consideration is the excavation of a burrow pit within the center of the new Toledo CDF to increase the volume of contaminated dredged material that can be placed below lake level. The excavated material should be of suitable quality to be used in a beneficial way. Additional testing and evaluation of the excavated material will be required to determine the appropriate use of the material.

For the Toledo CDFs, dewatered dredged material would be the logical material choice for upgrading the retaining dikes. Also, there is an on-going beneficial use application at the Port CDF with the Nu-Soil Operation. Both of these approaches for development of a RCDF should be examined.

5. Construction of New CDFs - Construction of new CDFs would be required once capacity in existing CDFs is reached. However, this option is unattractive because of the scarcity of nearshore land and the resulting reduction in aquatic habitat. Therefore, it should be considered as a last resort once CDF management, RCDFs, open lake disposal, beneficial use application, and other options are fully exhausted.

6. Ultimate Reusable CDF - Management of this CDF could be such that all materials required to produce soil products are provided on site *(Figure 24)*. For example, reconditioned sewage sludge and spent lime could be stockpiled at the CDF site for ready use in blending with dredged material to form specific soil products. Further evaluation of this concept should be pursued.

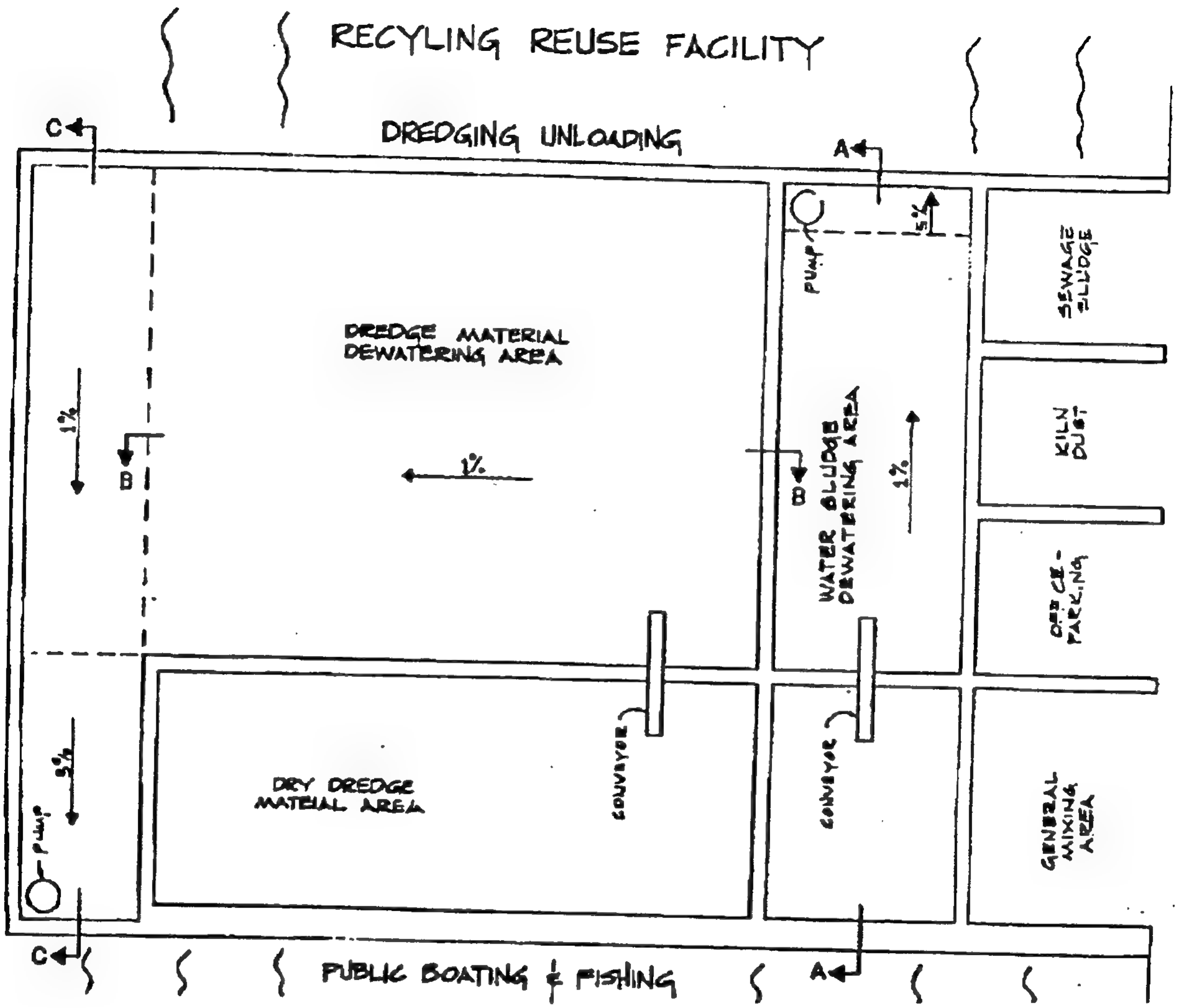


Figure 24 - Reusable (Recycle) CDF

F. OPEN-WATER DISPOSAL

Dredged material from Toledo Harbor (L mile-2 to L mile 12) has been placed at open-water disposal sites in Lake Erie during 1986-1992. Since 1992, a Section 401 certification allowed only dredged material from L mile-5 to L mile-12 to be open-water disposed at the open-water disposal site through 1994. After 1994, no further open-water disposal of dredged material would be allowed in accordance with the State's phosphorus reduction plan.

The State of Ohio has indicated its concern regarding the resuspension of the phosphorus-laden dredged material, and stated that its goal is to eliminate the open-lake disposal of phosphorus-laden dredged material from Toledo Harbor into the Western Basin of Lake Erie through the identification, development and utilization of long-term dredged material beneficial reuse or recycling.

Also, the International Joint Commission (IJC) in its review of the Stage 1 Remedial Action Plan for the Maumee River Area of Concern (river and lake) discussed the need for better baseline information regarding such matters as water quality, pollution sources, the distribution of toxic contaminants in sediments, and the condition of fish and wildlife communities.

Preliminary evaluation of the sediment quality data available on the dredging projects (Floyd Browne Associates, Ltd 1984, Aqua Tech Environmental Consultants 1986, T.P. Associates International 1987 and 1988) indicates that there appears to be no measurable difference in sediment quality between dredged material from L mile-2 through L mile-16, and sediment quality at the open-water disposal site or the open-lake reference site. Sediment toxicity testing appeared to indicate no measurable differences in biological response to sediments from L mile-4 to L mile-16 when compared to that of sediments from the open-water disposal site or the open-lake reference site (Giesy and Hoke 1988). Giesy and Hoke concluded that the level of toxicity observed in sediments from L mile-4 to L mile-16 and the open-water disposal site were similar to background levels in other locations in the western basin of Lake Erie un-impacted by dredged material disposal events. <u>Further analysis of existing data is needed to evaluate locations of sediment within the Toledo Harbor Lake Approach Channel that may not be different from Lake sediments at the open-water disposal site or the lake reference site.</u>

The Maumee Bay Bottom Characterization study indicated that sediments in the vicinity of the open-water disposal site were re-worked by storms and wave action (SAIC, 1989). Bedforms were observed that indicated high bottom shear stress and active sediment transport as bedload throughout the area was studied. Species able to survive bottom disturbances were observed to dominate the faunal community at some stations. In addition, the dominant surface and bottom current patterns in western

Lake Erie (*Figure 25*) appear to indicate significant potential for sediment transport within the Maumee Bay and western Lake Erie area of the open-lake channel (FWCA 1968). <u>Further observations and analysis of movement of sediments discharged in the open water is warranted to address the State and others' concerns regarding open-lake disposal and water quality.</u>

G. NO-ACTION PLAN

In planning studies, a No-Action plan is considered to establish a baseline from which all other alternative plans may be measured for their relative contribution to the planning objectives. For Toledo Harbor the No-Action plan is defined as:

- continuance of the historical Operation and Maintenance procedures used by the Corps of Engineers prior to the 1992 dredging season, consistent with Corps Dredging Policies and the current Federal standard for harbor operation and maintenance. This prior maintenance and operation practice called for placement of "contaminated" dredged materials from the Maumee River channel out to mile 2 of the Lake channel in CDFs. The dredged material from mile 2 lakeward to the 29-foot contour, considered non-contaminated, are discharged in the open-water at the designated discharge area in Western Lake Erie;

- continuance of effort by the State of Ohio (OEPA) to uphold water quality standards in the State through administration of the Section 401 Water Quality Program, and reduction of the load of contaminated sediment entering the Federal Channels;

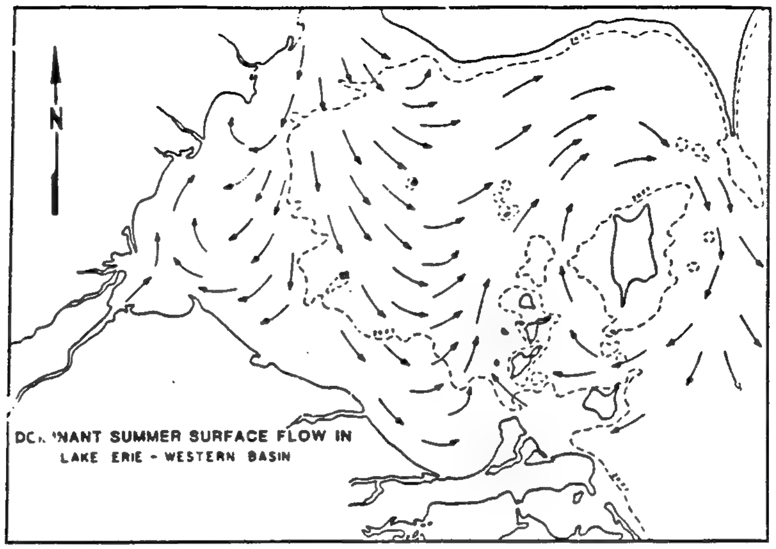
- continuance of effort by the Toledo-Lucas County Port Authority to identify, develop, and utilize long-term beneficial uses of dredged material from the Toledo Port and Harbor;

- the City of Toledo; ODNR and USFWS will continue to pursue their separate goals of providing quality drinking water for the City of Toledo, and preserving fish and wildlife habitats, respectively.

Having identified the No-Action plan, it is also important to recognize that the historical operation and maintenance plan for the dredging of Toledo Harbor has been changed through the development and execution of a two-year agreement between the partner agencies to continue open-water discharge of dredged material through 1994, as agreed to: dredged material from the river out to lake mile 5 will be placed in CDF; and dredged material from lake mile 5 lakeward will be discharged in the open lake. This practice will continue through the completion of the 1994 dredging cycle. Since no mechanism or authority currently exists to continue this practice beyond the

1994 dredging cycle, it cannot be considered the No-Action plan, but it establishes the beginning of the undetermined time period for the No-Action plan.

Reverting back to the No-Action plan after current agreements expire would cause a major conflict among the partner agencies. A potential consequence of the inability of these agencies to reach agreement would be a reduction in the level of maintenance dredging at Toledo Harbor, which would reduce and eventually preclude its use as a commercial harbor. The task of developing a LTMS is a direct outgrowth of this conflict and the evolution of a general agreement between these agencies to work together towards achieving individual goal(s) through implementation of mutually acceptable plan(s) for the benefit of all. The LTMS effort is not seeking the No-Action plan, it rather seeks a more permanent medium to long-term solution(s) to the problem of managing the dredged material at Toledo Harbor.



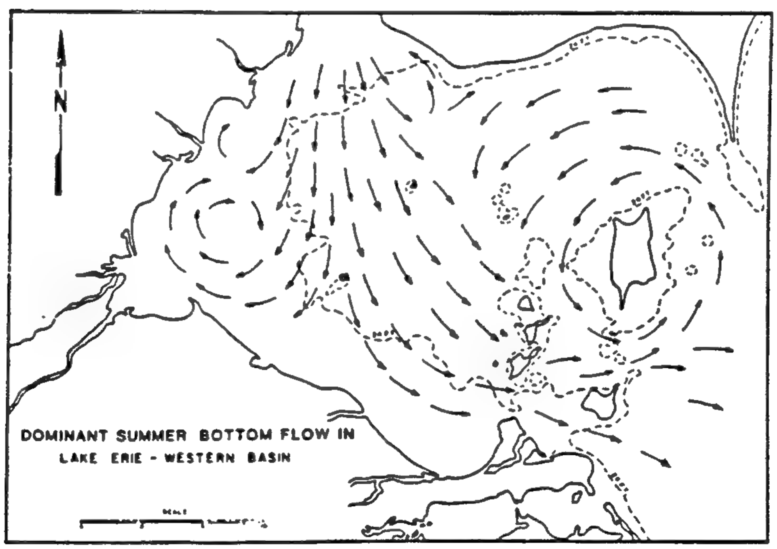


Figure 25 - Dominant Surface and Bottom Current Patterns in Western Lake Erie

H. OPTIONS ELIMINATED EARLY

As discussed earlier in this Section of the report, the following options do not warrant further consideration at this time, and therefore, will not be given any further consideration in the development of this LTMS.

1. Filter Strips

2. Streambank Erosion Control

3. Pest Management

I. OPTIONS CARRIED FORWARD

The following options will be given further consideration during the phase 2 evaluation:

1. Sediment Load Reduction

    a. Non-Structural Measures
        (1) Crop Residue Management
        (2) Conservation Cropping Sequence
        (3) Alternative Crops

    b. Structural Measures
        (1) Grassed Waterway
        (2) Creation of Wetlands/Sedimentation Ponds
        (3) Agricultural Runoff Retention Reservoir

2. Beneficial Uses

    a. Nu-Soil products

    b. N-Viro Soil products

3. Environmental Restoration

    a. Woodtick Peninsula

    b. Development of Shallow Water Habitat

4. Confined Disposal Facilities

    a. Raising Existing CDF Dike Elevations

    b. Management of CDF for Maximum Storage

    c. CDF Reuse Management

    d. Ultimate Reusable (Recycling) CDF

    e. Construction of new CDF

5. Open-Water Disposal

6. No-Action

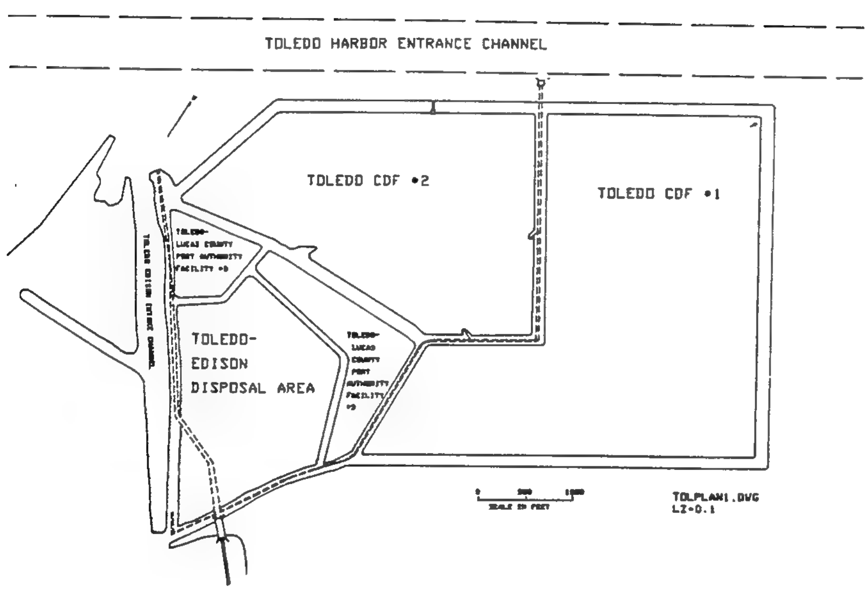
Implementation of an LTMS for Toledo Harbor will take several years. An intermediate or transition plan is needed for management of sediment prior to implementation of the LTMS. A Section 401 water quality certification has been agreed to as issued by OEPA for disposal in 1993 and 1994. This certification calls for material from lake mile 5-inland to go into CDFs. Material from lake mile 5-lakeward will be placed at the open-lake disposal area.

The portion of materials from the channel that has been open-lake disposed and contained in CDFs has been based on USEPA Region 5 sediment criteria and administrative agreement. Once an updated EPA/USACE Inland Testing Manual and accompanying regional implementation manual are in place, they will provide a technically sound basis for assessing the acceptability of materials for open-lake disposal.

At this time, the more likely options for, or components of, preliminary conceptual intermediate/Long-Term Plan(s) are discussed below. They include continuation and possible expansion of beneficial use options, sediment load reduction, open-lake disposal, habitat restoration, and use of present CDFs, as summarized on *Figure 26, Figure 27, and Figure 28.*

A. INTERMEDIATE USE OF TOLEDO CDF #1

Considering the provisions of the present Section 401 certification, the dredged material from lake mile 5 inland (an estimated in-channel volume of 600,000 cubic yards) must be placed in Toledo Harbor CDF #1 in 1993. Assuming no volume change from in-channel to a stage of **early consolidation**, this would leave approximately 400,000 cubic yards of volumetric capacity in the Toledo harbor CDF #1 after the 1993 dredging cycle. This is only a portion of the capacity needed to accommodate the 1994 maintenance from lake mile 5 inland. The 1994 material would necessarily be placed partially in the Toledo Harbor CDF #1 with the remainder placed in the Toledo Harbor CDF #2. Following 1994 work, the Toledo Harbor CDF #1 will be essentially filled. This site should not be used further during the intermediate plan, but should be managed for dewatering and expansion of beneficial uses options.



1993
600000 CY IN TOLEDO CDF #1
300000 CY IN OPEN-LAKE

1994
400000 CY IN TOLEDO CDF #1
200000 CY IN TOLEDO CDF #2
300000 CY IN OPEN-LAKE
BEGIN DEWATERING EASTERN PORTION OF TOLEDO CDF #1

1995
600000 CY IN TOLEDO CDF #2
300000 CY IN OPEN-LAKE
CONTINUE DEWATERING EASTERN PORTION OF TOLEDO CDF #1
BEGIN MINING WESTERN PORTION OF TOLEDO CDF #1

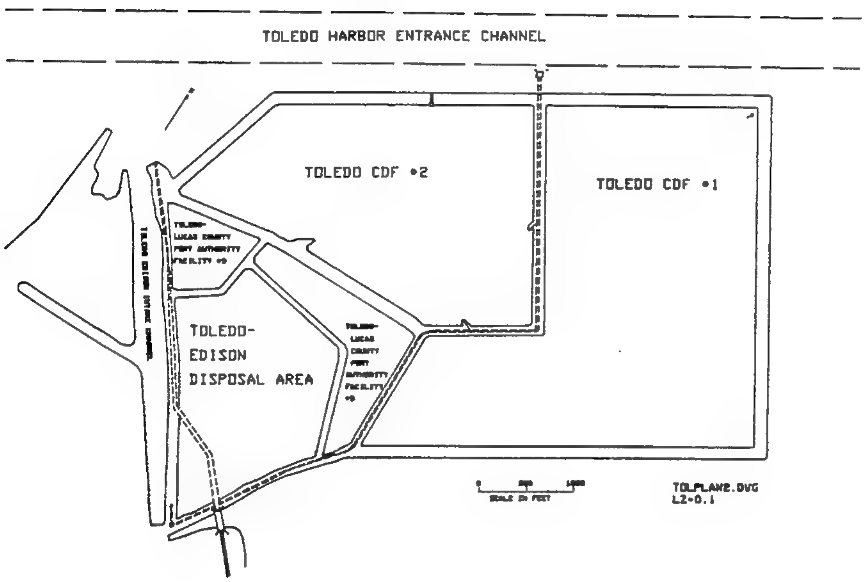
1996
600000 CY IN TOLEDO CDF #2
300000 CY IN OPEN-LAKE
CONTINUE DEWATERING EASTERN PORTION TOLEDO CDF #1
CONTINUE MINING WESTERN PORTION OF TOLEDO CDF #1

1997
600000 CY IN TOLEDO CDF #2
NOTE: MATERIAL EXCEEDS LAKE LEVEL. BEGIN DEWATERING
300000 CY IN OPEN-LAKE
CONTINUE DEWATERING EASTERN PORTION TOLEDO CDF #1
CONTINUE MINING WESTERN PORTION OF TOLEDO CDF #1

1998
TRANSITION ENDS:
- WATER QUALITY CRITERIA IN PLACE
- LOWER DREDGED MATERIAL QUANTITY DUE TO SEDIMENT LOAD REDUCTION
- GRASSY ISLAND RESTORATION
- WOODTICK PENINSULA RESTORATION
- INCREASED MINING OPERATION (BENEFICIAL USE)
- MANAGE CDF (DEWATERING)
- NO OPEN-LAKE DISPOSAL

FUTURE
ULTIMATE REUSABLE CDF

Figure 26 - *Conceptual Intermediate Long-Term Action Plan 1*



1993
600000 CY IN TOLEDO CDF #1
300000 CY IN OPEN-LAKE

1994
400000 CY IN TOLEDO CDF #1
200000 CY IN TOLEDO CDF #2
300000 CY IN OPEN-LAKE
BEGIN DEWATERING EASTERN PORTION OF TOLEDO CDF #1

1995
600000 CY IN TOLEDO CDF #2
300000 CY IN SHALLOW-WATER HABITAT
CONTINUE DEWATERING EASTERN PORTION OF TOLEDO CDF #1
BEGIN MINING WESTERN PORTION OF TOLEDO CDF #1

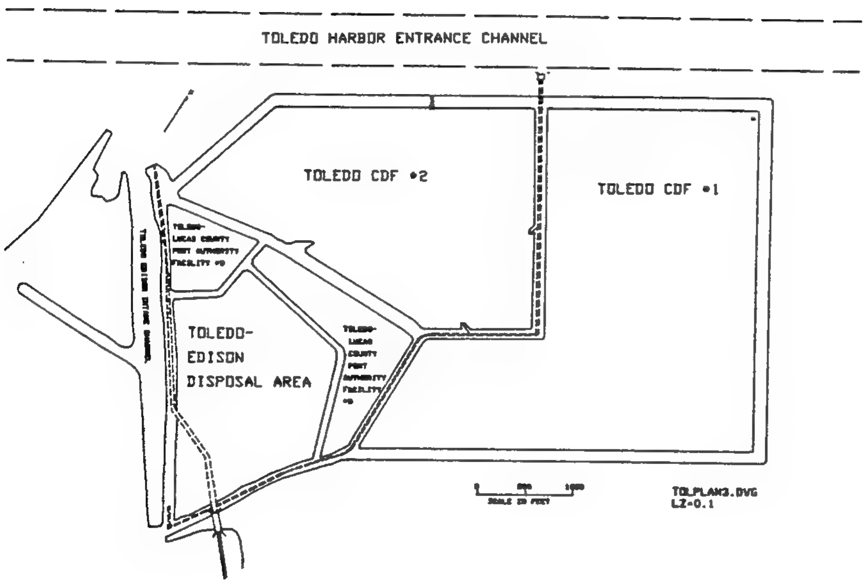
1996
600000 CY IN TOLEDO CDF #2
300000 CY IN SHALLOW-WATER HABITAT
CONTINUE DEWATERING EASTERN PORTION TOLEDO CDF #1
CONTINUE MINING WESTERN PORTION OF TOLEDO CDF #1

1997
600000 CY IN TOLEDO CDF #2
NOTE: MATERIAL EXCEEDS LAKE LEVEL. BEGIN DEWATERING
300000 CY IN SHALLOW-WATER HABITAT
CONTINUE DEWATERING EASTERN PORTION TOLEDO CDF #1
CONTINUE MINING WESTERN PORTION OF TOLEDO CDF #1

1998
TRANSITION ENDS:
- WATER QUALITY CRITERIA IN PLACE
- LOWER DREDGED MATERIAL QUANTITY DUE TO SEDIMENT LOAD REDUCTION
- GRASSY ISLAND RESTORATION
- WOODTICK PENINSULA RESTORATION
- INCREASED MINING OPERATION (BENEFICIAL USE)
- MANAGE CDF (DEWATERING)
- CONTINUE HABITAT CREATION

FUTURE
ULTIMATE REUSABLE CDF

Figure 27 - *Conceptual Intermediate/Long-Term Action Plan 2*



1993
600000 CY IN TOLEDO CDF #1
300000 CY IN OPEN-LAKE

1994
400000 CY IN TOLEDO CDF #1
200000 CY IN TOLEDO CDF #2
300000 CY IN OPEN-LAKE
BEGIN DEWATERING EASTERN PORTION OF TOLEDO CDF #1

1995
600000 CY IN TOLEDO CDF#2
300000 CY IN GRASSY ISLAND
CONTINUE DEWATERING EASTERN PORTION OF TOLEDO CDF #1
BEGIN MINING WESTERN PORTION OF TOLEDO CDF #1

1996
600000 CY IN TOLEDO CDF #2
300000 CY IN SHALLOW-WATER HABITAT
CONTINUE DEWATERING EASTERN PORTION TOLEDO CDF #1
CONTINUE MINING WESTERN PORTION OF TOLEDO CDF #1

1997
600000 CY IN TOLEDO CDF #2
NOTE: MATERIAL EXCEEDS LAKE LEVEL. BEGIN DEWATERING
300000 CY IN GRASSY ISLAND/HABITAT
CONTINUE DEWATERING EASTERN PORTION TOLEDO CDF #1
CONTINUE MINING WESTERN PORTION OF TOLEDO CDF #1

1998
TRANSITION ENDS:
- WATER QUALITY CRITERIA IN PLACE
- LOWER DREDGED MATERIAL QUANTITY DUE TO SEDIMENT LOAD REDUCTION
- GRASSY ISLAND RESTORATION
- WOODTICK PENINSULA RESTORATION
- INCREASED MINING OPERATION (BENEFICIAL USE)
- MANAGE CDF (DEWATERING)
- CONTINUE HABITAT CREATION

FUTURE
ULTIMATE REUSABLE CDF

Figure 28 - Conceptual Intermediate/Long-Term Action Plan 3

B. INTERMEDIATE USE OF TOLEDO HARBOR CDF #2

The Toledo Harbor CDF #2 is a valuable disposal resource which should be reserved for materials unacceptable for open-lake disposal. In addition, the most contaminated materials from the Maumee River should be placed in the site first, so that cleaner materials can be placed above as a cap to further minimize exposure to the environment.

Approximately 1.8 million cubic yards of capacity in this site is below lake level, and materials below this elevation cannot be managed for dewatering. Placement of the balance of the 1994 maintenance dredged material not being placed in the existing Toledo Harbor CDF #1 will only occupy approximately 200,000 cubic yards, leaving 1.6 million cubic yards below lake level. This capacity should be used in 1995 and beyond, only for materials found to be unsuitable for open-lake disposal using procedures in the EPA/USACE Inland Testing Manual and regional implementation manual.

If the new testing procedures do not change the relative proportion of Maumee River sediments going to CDFs, the Toledo Harbor CDF #2 would have capacity to accommodate the 1995 and 1996 dredging cycles with the 1997 cycle exceeding the lake level elevation. Beyond this time, the LTMS should be implemented to include any management approaches to extend the storage volume for materials placed above the lake level elevation.

C. INTERMEDIATE BENEFICIAL USES

The major beneficial use option now underway for the fine-grained material is for amended top soil. This option is presently used on a relatively small area adjacent to the Toledo Harbor CDF #1. During the intermediate plan period, the area used for such operations should be expanded to the western portion of the Toledo Harbor CDF #1. Depending on the condition of the site following 1993 dredging, this may require construction of a cross dike to separate the eastern and western portions of the site.

D. INTERMEDIATE USE OF OPEN-LAKE DISPOSAL

The present Section 401 water quality certification calls for open-lake disposal of materials from lake mile 5 lakeward in both 1993 and 1994. The current data indicate the volumes from this reach are approximately 300,000 cubic yards annually.

The USEPA/USACE Inland Testing Manual will be available for field review during the spring of 1993. The regional implementation manual will be available shortly thereafter. The technical guidance in these manuals should be used to determine the suitability of Maumee River sediments for open lake disposal for the

1995 dredging cycle and beyond. Considering future technical guidance in the above manuals, and reassessment of resuspension of sediments due to wind/wave movement, phosphorus loading, the proportion of Maumee River sediments that could be acceptable for open-lake site may change.

These preliminary concepts of intermediate/long-term plans are proposed to help the Planning Group keep emphasis on and achieve one of its important goals of keeping the Port of Toledo open and safe for navigation, particularly during this transition period up to the execution of the approved LTMS. One should not assume that these preliminary concepts are or will be recommended for detailed studies in the implementation phase of the study. They may or may not, based on the findings and results of technical and other studies.

VI. SUMMARY OF CONCLUSIONS

A. GEOGRAPHIC LIMITS AND TIME FRAME

Dredging is required to maintain the Federal navigation channels at Toledo Harbor. Most of the dredged material from these channels between the early 1960's and 1977 was placed in Island 18, and in the currently used Confined Disposal Facilities beginning in 1978. However, the currently used facility will reach capacity in two years or less, and as managed, will not have any available capacity in the long term. Other available disposal resources range from the new 20-year-capacity CDF which will be available by 1995, Island 18, and open-lake disposal which has been controversial. In any event, if the existing CDFs are not managed to their full potential, the new facility will not be able to accommodate 50 years (long-term) of continued maintenance dredging operations at Toledo Harbor.

Further, considering the impact on dredging of the sediment load reduction effort throughout the Maumee River Watershed, and potential future beneficial uses of the dredged material for environmental restoration in Michigan waters, the geographic limits for the LTMS should encompass the total Maumee River Basin from Fort Wayne, Indiana, through North Cape which extends south from Michigan, to Little Cedar Point which extends northwest from Ohio. Based on the above, a 50-year Long-Term Dredged Material Management Plan within the context of the Sediment Management Strategy for the Maumee River Watershed is considered appropriate and is being sought.

B. DREDGING REQUIREMENTS

Dredging required for Toledo Harbor is limited to the Federal navigation channels from the river mouth (mile 0) to river mile 7, and from mile 0 to lake mile 18. Dredging at Toledo Harbor has been performed by hydraulic dredges utilizing pumping station(s) to boost and add energy to the suction system, and by mechanical dredges to fill barges which transport the dredged material to the CDF site(s).

Considering the estimated shoaling rates of 0.5 to 1.0 foot per year in the downstream end of the river to lake mile 0; 2 to 2.5 feet from lake mile 3 to lake mile 6; and lower rates further lakeward, the near future dredging quantities are expected to mirror recent dredging operations. Therefore, average annual total dredging quantities will be on the order of 850,000 to 900,000 cubic yards per year from both the river and lake channels as follows:

1. From the Maumee River, approximately 300,000 to 400,000 cubic yards per year.

2. From the Lake, 550,000 to 650,000 cubic yards per year.

Considering sediment load reduction efforts over the 50-year life of this LTMS, a projection of the total dredging quantity that must be accommodated over this period is estimated to be about 30,000,000 to 45,000,000 cubic yards. However, only 9.9 million cu. yds of CDF capacity is currently available to contain this material. Therefore, additional capacity would be required to accommodate the estimated dredging quantities.

C. MATERIAL CHARACTERISTICS

Previous physical testing showed that sediment from the river channels and the lake consisted of 88 percent silts and clays, with the remainder coarse-grain material (sand and gravel). In some instances, sediment samples consisted of 80 to 98 percent silts and clays. Previous dry weight bulk inorganic data on the sediments indicated that higher levels of arsenic, barium, cyanide and phosphorus and iron were measured in most of the sediment samples. Generally, heavy metals and nutrient contamination is highest in the river channel sediment samples, particularly from the lower reach. Results of organic analyses performed indicated that no Pesticides, PCBs or Purgeable Halocarbons were detected in any of the sediment samples. Elutriate testing performed with the sediment indicated moderate to higher releases of some parameters. The ninety-six hour bioassay testing performed on all Lake sediment samples classified these sediment samples as "nonpolluted" to "moderately polluted." River Channel sediment samples, particularly from the lower reach, were categorized overall as "moderately polluted" to "heavily polluted."

The dredged material from Toledo Harbor should generally be tested according to the upcoming Inland Testing Manual and the Regional Testing Manual to determine its suitability for disposal at appropriate disposal sites, or used beneficially as appropriate.

D. ENVIRONMENTAL CONCERNS

All environmental resources identified in this report are of concern for this LTMS, particularly those associated with fish and wildlife in the Maumee Bay and vicinity, and to a lesser extent the Maumee River. Loss of wetlands, submerged aquatic macrophyte plant beds in the Bay, shallow water habitat, as well as potential botulism outbreak, and improper management of CDFs, are significant concerns. With regard

to threatened and endangered species, the American bald eagle has a broad range that includes Lake Erie. The Toledo area lies within that range of the bald eagle as well as the Indiana bat, which are both Federally- listed endangered species. To date, no critical habitats for these species have been found in the immediate vicinity of the CDFs in this locale.

Environmental concerns most often cited regarding dredging and open-water disposal in the study area are loss or alteration of aquatic fish and wildlife habitat resulting from impact of construction activities, and temporary resuspension of phosphorus-laden sediment and other pollutants in the water column of the Western Basin of Lake Erie. Release of some pollutants in some instances temporarily exceeded State Water Quality Standards. Currently, a significant State concern is the release of phosphorus into the water column.

E. DISPOSAL ALTERNATIVES

Sediment management options identified during this phase 1 include confined disposal, open-water disposal, and beneficial uses. A summary of the disposal site capacities is shown in the *Table 4 shown below.* The following constraints on available disposal options or sites were assumed:

- Considering the scarcity of land in the project area, and the USFWL and ODNR's concern regarding loss of shallow water habitats, only the Island 18, and the existing and new CDFs within the port boundaries were considered available disposal options.

- Considering the regulatory or environmental protection agencies' concerns over possible impact on water quality of dredged material discharged into the open-water site in Western Lake Erie and vicinity, and the difficulty in designating or selecting a new site, only the previously used open-lake site was considered a potential option

Finding suitable CDF site(s) within the existing project area is complicated by various environmental concerns, including the presence of shallow water habitat, the boaters and fishermen. The City of Oregon expressed concern over locating new CDF sites on the nearshore zone bordering their City. Aesthetics and/or obstruction of the lake view were cited as reasons for their opposition to building new CDFs.

Table 4 - Remaining Capacities at CDF and Open Water

Site Location	Confined Disposal Facility Capacity Cubic Yards	Open-Lake Disposal Site Capacity Cubic Yards
CDF # 1	1,000,000	-
CDF # 2	8,700,000	-
Island # 18	295,000	-
Facility # 3	None	-
TOTAL	9,995,000	(1)

(1) In the past about 300,000 to 600,000 cubic yards per year have been discharged in the open-lake site.

F. BENEFICIAL USES

In addition to the soil products being manufactured by S&L fertilizer and N-Viro Systems, Ltd, the dredged material can be used beneficially for environmental restoration, wildlife habitat, and creation of shallow water habitat. While the Planning Group encourages the development of the process of using dredged material along with other biosolids to make value-added products, it does not endorse any particular product(s). The Group therefore leaves the process open for the benefit of all on equal terms.

G. COMPARISON OF DREDGING REQUIREMENTS & DISPOSAL RESOURCES

The total estimated dredging quantities for Toledo Harbor over the 50-year life of an LTMS would be approximately 45,000,000 cu. yds. assuming no significant sediment load reduction, or 30,000,000 cu. yds. assuming successful sediment load reduction. In either case, the estimated quantity exceeds the maximum total available volumetric capacity of 9,995,000 cu. yds. Only a portion of the material is suitable for open-water disposal which is controversial. Based on these dredging quantities and consideration thereof, the **required dredging capacity** would far exceed the capacity of 9.9 million cu. yds. available in the existing and new CDFs. Therefore, use of a significant portion of the dredged material should be considered for long-term beneficial uses, environmental restoration and/or enhancement, and creation of

shallow water habitats. Further, management of these CDFs must be initiated soon, with implementation of the intermediate/transition plan leading to the LTMS. Also, based on existing information, it would appear that sediment from certain portions of the Toledo Harbor channel, namely the Maumee Bay portion, would be suitable for disposal at the existing open-water disposal site. Further sediment sampling and evaluation must be performed to determine those locations within the Toledo Harbor channels that are similar in sediment quality. In addition, further evaluation of the suitability of sediments for open-water disposal according to the upcoming Inland Testing Manual and the Great Lakes Testing and Evaluation Manual is warranted.

The LTMS for Toledo Harbor will likely involve a combination of: management of Confined Disposal Facilities, sediment load reduction, management of contaminants, beneficial uses of dredged material, including environmental restoration. Beneficial use should be considered a high priority option; reusable or recycling CDFs should be considered a prime option for disposal of material; open-water disposal should be considered a potential option for only those materials that are tested as being acceptable according to the new 404 Testing Manual and State Water Quality Standards.

VII. PHASE 2 ACTIVITIES

Phase 2 activities for the LTMS process are associated with the formulation of appropriate alternatives. The requirements for specific engineering and environmental studies should be determined. Based on the results of this Phase 1 effort, the following general and specific activities are recommended for Phase 2:

A. GENERAL ACTIVITIES

In Section IV of this report, several management options were identified as options to carry over into Phase 2 of the LTMS for further consideration. These management options including structural and non-structural options will be systematically screened and combined into preliminary plans which will be studied further in phase 3 with a view to identifying potentially viable Long-Term Sediment Management **Action Plans** for detailed studies and implementation in Phase 4. The following pertinent general activities are recommended:

○ Determine environmental, engineering, and economic criteria for dredging and management of the dredged material within the sediment management effort for the Maumee River.

○ Evaluate and screen alternatives using available information

○ Determine the need for further investigations beyond the Action Plan such as sediment and water quality, hydraulic and sediment transport, and other areas of interest relative to selection of dredging methods, transportation system, and disposal options. Prioritize the needs based on value to project and cost effectiveness.

B. SPECIFIC ACTIVITIES

These following specific activities warrant further consideration as discussed in Section IV of this report:

○ Assess crop residue management (no till, conserv. tillage)

○ Assess impact and additional markets of conservation cropping sequence for the long range study;

○ Obtain additional information on the market and pricing service for Canola as an alternative crop;

- Investigate Agricultural Runoff Retention Reservoir Concept and grassed waterway as means to further reduce the load of sediment in the watershed;

- Investigate the feasibility of wetland creation and possible investment return from wildlife;

- Evaluate reduction of nitrogen by implementation of nutrient management;

- Study the potential for reduction of animal waste constituent in the Maumee River Watershed;

- Further evaluate and quantify the productive use of the dredged material as a component of manufactured soils or products thereof;

- Perform required testing to determine the structural requirements and potential conditioning of the dredged material for construction of a recreational hill;

- Productive use of dredged material to develop shallow water habitat

- Further evaluate the restoration of the Woodtick Peninsula with dredged material;

- Evaluate the concept of ultimate reusable (recycling) CDF, CDF management, open-water disposal, and other options.

VIII. RECOMMENDATION

Based on the result of this Phase 1 investigation and the conclusions reached in this Progress Report, the Planning Group recommends that the phase 2 study be conducted to further address these conclusions and ultimately complete the formulation of long-term dredged material management strategies (LTMS) for Toledo Harbor within the context of developing a sediment management strategy for the Maumee River.

This recommendation addresses management options to prolong the use of dredged material Confined Disposal Facilities, the development of beneficial uses for dredged material and the overall reduction in the quantity and increase in the environmental quality of eroded soil and sediment that enters the Maumee River.

FOR THE EXECUTIVE COMMITTEE:

JOHN W. MORRIS
Colonel, US Army
Chairman,

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REMEDIAL ACTION PLAN

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APPENDICES

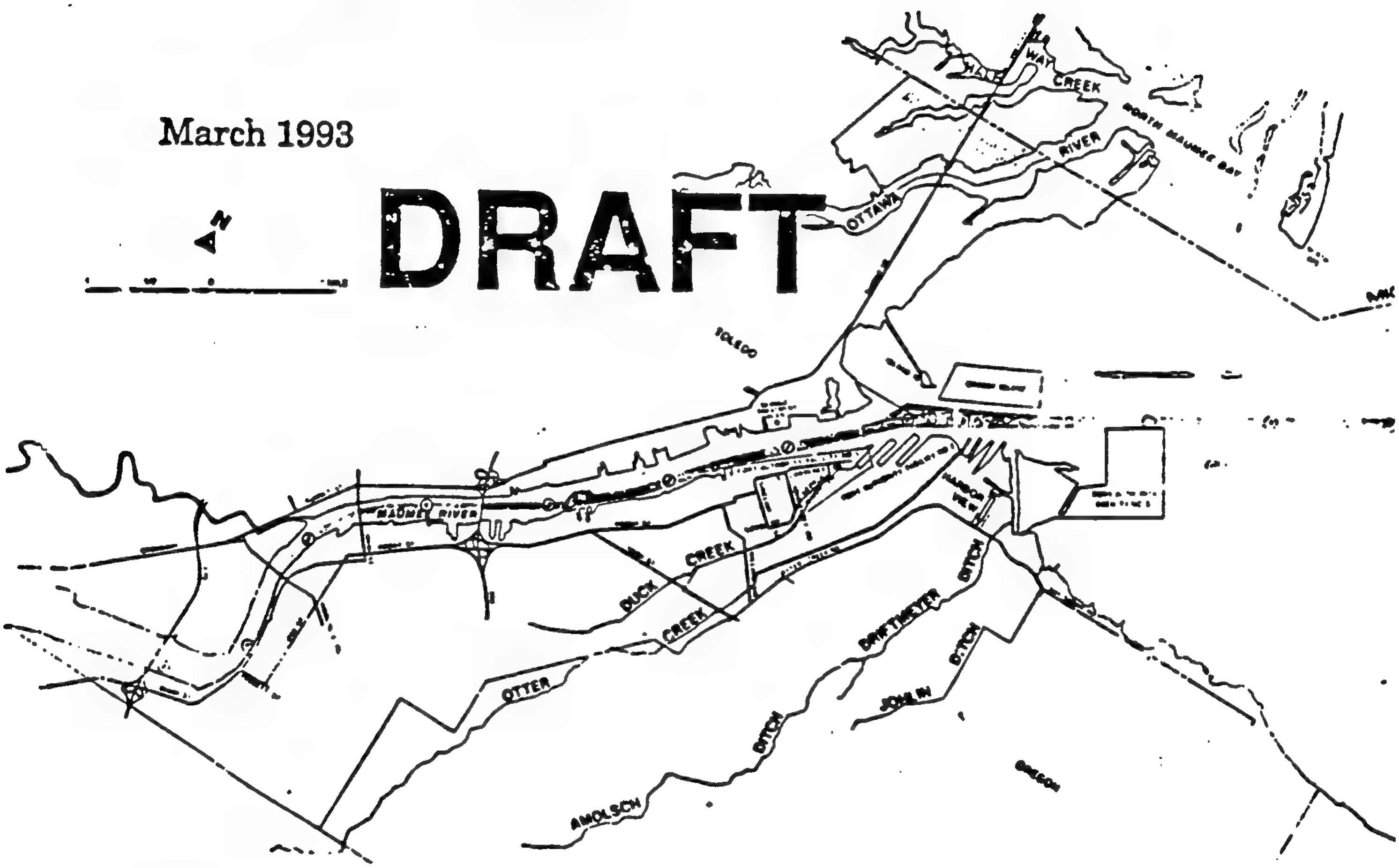
Long-Term Dredged Material Management Plan within the context of Maumee River Watershed Sediment Management Strategy

Toledo Harbor, OH

Phase 1 Report

March 1993

DRAFT



Planning Group:

U.S. Army Corps of Engineers
U.S. Soil Conservation Service
U. S. Environmental Protection Agency
U.S. Fish and Wildlife Service
Michigan Dept. of Natural Resources

City of Toledo
Ohio Dept. of Natural Resources
Ohio Environmental Protection Agency
Ohio Lake Erie Office
Toledo Lucas Co. Port Authority

APPENDIX A

DREDGING QUANTITY DATA

TABLE 2. DREDGING QUANTITIES BY STATION, 1992

556	500	1609.1	1390.4	534.3	3533.8	655.2	1040.6	437.6	2133.4	1400.4	2.8008	0.756216	199075.6
557	500	1642.2	1390.7	638.7	3671.6	677.6	1112	359.3	2148.9	1522.7	3.0454	0.822258	200598.3
558	500	1796.5	1378	555.7	3730.2	822.6	1207.6	595.2	2625.4	1104.8	2.2096	0.596592	201703.1
559	500	1781.7	1388.7	540.9	3711.3	903	1049.4	855.9	2808.3	903	1.806	0.48762	202606.1
560	500	1821.9	1403.9	675	3900.8	579.6	728	699.1	2006.7	1894.1	3.7882	1.022814	204500.2
561	500	2043.4	1426.4	669.6	4139.4	483.4	690.8	686.6	1860.8	2278.6	4.5572	1.230444	206778.8
562	500	2266.7	1435.7	697.4	4399.8	655	834.6	825.6	2315.2	2084.6	4.1692	1.125684	208863.4
563	500	2605.7	1434.8	640.9	4681.4	796.9	977.8	913.7	2688.4	1993	3.986	1.07622	210856.4
564	500	2809.3	1435	830.2	5074.5	852.8	1056.5	645.9	2555.2	2519.3	5.0386	1.360422	213375.7
565	500	3123.3	1469.1	1061.9	5654.3	906.9	1137.4	400.9	2445.2	3209.1	6.4182	1.732914	216584.8
566	500	3284.1	1465.4	1048.9	5798.4	873.7	1124.8	504.1	2502.6	3295.8	6.5916	1.779732	219880.6
567	500	3261.9	1450.2	897.4	5609.5	936.5	1118.7	717.6	2772.8	2836.7	5.6734	1.531818	222717.3
568	500	3241.1	1437	624.3	5302.4	820.7	1099.8	744.1	2664.6	2637.8	5.2756	1.424412	225355.1
569	500	3347	1437.4	650.9	5435.3	598	1114.6	467	2179.6	3255.7	6.5114	1.758078	228610.8
570	500	3482.2	1440.6	665.7	5588.5	635.9	1179.8	415.9	2231.6	3356.9	6.7138	1.812726	231967.7
571	500	3919.8	1442	714.4	6076.2	820.3	1244.8	765.2	2830.3	3245.9	6.4918	1.752786	235213.6
572	500	4633	1466.1	925.6	7024.7	981.3	1340.6	912.8	3234.7	3790	7.58	2.0466	239003.6
573	500	4931.7	1467.2	1008.9	7407.8	999.8	1373.9	747.2	3120.9	4286.9	8.5738	2.314926	243290.5
574	500	4692.4	1472.6	952.2	7117.2	934.3	1306.7	671.7	2912.7	4204.5	8.409	2.27043	247495
575	500	4290.4	1471.3	795.6	6557.3	737.6	1125.4	712.8	2575.8	3981.5	7.963	2.15001	251476.5
576	500	4128.7	1459.8	624.1	6212.6	670.2	1017.8	789.8	2477.8	3734.8	7.4696	2.016792	255211.3
577	500	4272	1459.8	798.3	6530.1	702.4	1067	920.4	2689.8	3840.3	7.6806	2.073762	259051.6
578	500	4474.1	1443.5	902.6	6820.2	569.3	981.3	831.4	2382	4438.2	8.8764	2.396628	263489.8
579	500	4506.1	1442.4	846.9	6795.4	620	1000	802.2	2422.2	4373.2	8.7464	2.361528	267863
580	500	4569.6	1480	931.1	6980.7	829.3	1096.1	982.8	2908.2	4072.5	8.145	2.19915	271935.5
581	500	4699.3	1500.6	1151.7	7351.6	849.3	1073	1021.5	2943.8	4407.8	8.8156	2.380212	276343.3
582	500	4676.5	1495	1369.8	7541.3	788.9	1047.4	813.5	2649.8	4891.5	9.783	2.64141	281234.8
583	500	4709.4	1484.8	1424.6	7618.8	750.6	1055	865	2670.6	4948.2	9.8964	2.672028	286183
584	500	4869.8	1498.9	1342.4	7711.1	896.9	1100.7	1243	3240.6	4470.5	8.941	2.41407	290653.5
585	500	4980.7	1507.2	1177.6	7665.5	1224.8	1150.9	1518	3893.7	3771.8	7.5436	2.036772	294425.3
586	500	4892.6	1483.7	1278.7	7655	1091.5	1111.9	1236.3	3439.7	4215.3	8.4306	2.276262	298640.6
587	500	4654.1	1486.3	1473.3	7613.7	1062.6	1087.2	1132.6	3282.4	4331.3	8.6626	2.338902	302971.9
588	500	4850.4	1517.2	1362	7729.6	1234.3	1145	1478.7	3858	3871.6	7.7432	2.090664	306843.5
589	500	5073.9	1521.1	997.6	7592.6	1179.3	1147.6	1410.9	3737.8	3854.8	7.7096	2.081592	310698.3
590	500	5119.6	1522.2	1077.8	7719.6	1123.1	1257.2	1099.3	3479.6	4240	8.48	2.2896	314938.3
591	500	5378.7	1529.1	1364.3	8272.1	1188.1	1413.5	822.2	3423.8	4848.3	9.6966	2.618082	319786.6
592	500	5513.1	1535.9	1176.9	8225.9	1395.6	1464.6	822.2	3682.4	4543.5	9.087	2.45349	324330.1
593	500	5469.3	1548.1	975.4	7992.8	1525.4	1434.4	1064.6	4024.4	3968.4	7.9368	2.142936	328298.5
594	500	5442.4	1550.4	976.9	7969.7	1358	1373.1	992.2	3723.3	4246.4	8.4928	2.293056	332544.9
595	500	5304.1	1552.2	990.2	7846.5	1200.2	1383.7	717	3300.9	4545.6	9.0912	2.454624	337090.5
596	500	5378.3	1551.3	980.2	7909.8	1436.7	1431.3	846.3	3714.3	4195.5	8.391	2.26557	341286
597	500	5657.6	1556.5	870.6	8084.7	1618.1	1463.9	1007.2	4089.2	3995.5	7.991	2.15757	345281.5
598	500	5874.6	1563.9	785.9	8224.4	1627.4	1509.8	722.8	3860	4364.4	8.7288	2.356776	349645.9
599	500	5989.6	1547.2	920.4	8457.2	1783	1542.2	372	3697.2	4760	9.52	2.5704	354405.9
600	500	6066.9	1538.7	898.3	8503.9	1902.6	1532.4	589.1	4024.1	4479.8	8.9596	2.419092	358885.7
601	500	6088.7	1554.1	702.6	8345.4	1704.1	1484.4	748.1	3936.6	4408.8	8.8176	2.380752	363294.5
602	500	5893.1	1556.1	613	8062.2	1507	1503.7	548.7	3559.4	4502.8	9.0056	2.431512	367797.3
603	500	5730.2	1553.3	528.1	7811.6	144.5	1533.3	451.9	2129.7	5681.9	11.3638	3.068226	373479.2
604	500	5843	1556.9	501.5	7901.4	1527.8	1489.1	523.5	3540.4	4361	8.722	2.35494	377840.2
605	500	5981.1	1555	531.3	8067.4	1681.1	1461.5	575.9	3718.5	4348.9	8.6978	2.348406	382189.1
606	500	5990.4	1550.6	510.6	8051.6	1629.4	1480.4	438.9	3548.7	4502.9	9.0058	2.431566	386692
607	500	5940.7	1569.6	589.4	8099.7	1550.4	1483.1	324.3	3357.8	4741.9	9.4838	2.560626	391433.9
608	500	5763.7	1584.3	651.3	7999.3	1488.9	1388.1	468.3	3345.3	4654	9.308	2.51316	396087.9
609	500	5526.9	1565	600.7	7692.6	1423	1237	723.1	3383.1	4309.5	8.619	2.32713	400397.4
610	500	5374.3	1547	630	7551.3	1172.8	1063	642.6	2878.4	4672.9	9.3458	2.523366	405070.3
611	500	5196.6	1524.4	465.2	7186.2	2710.8	1388.2	462.6	4561.6	2624.6	5.2492	1.417284	407694.9

TABL[illegible]. DREDGING QUANTITIES BY STATION, 1992

612	500	5330.9	1539.6	472.8	7343.3	2083.3	1205.9	482.8	3772	3571.3	7.1426	1.928502	411266.2
613	500	5505.4	1558.3	591.5	7655.2	1603.3	1075.7	697.6	3376.6	4278.6	8.5572	2.310444	415544.8
614	500	5556.5	1551.5	703.7	7811.7	1824.3	1269.3	835	3928.6	3883.1	7.7662	2.096874	419427.9
615	500	5672.6	1546.1	639.8	7858.5	2060	1433	852.4	4345.4	3513.1	7.0262	1.897074	422941
616	500	5787.8	1558.9	613.9	7960.6	2149.1	1436.5	647.8	4233.4	3727.2	7.4544	2.012688	426668.2
617	500	5771.7	1562.6	752.2	8086.5	2050.4	1473.1	570.6	4094.1	3992.4	7.9848	2.155896	430660.6
618	500	5763.5	1553.9	858.1	8175.5	2027.8	1513.7	771.7	4313.2	3862.3	7.7246	2.085642	434522.9
619	500	5800.7	1560.9	728.3	8089.9	2128	1510.2	760.9	4399.1	3690.8	7.3816	1.993032	438213.7
620	500	5705.4	1559.3	630.4	7895.1	2048.5	1459.8	682.9	4191.2	3703.9	7.4078	2.000106	441917.6
621	500	5544.6	1530.6	795	7870.2	1903.1	1377.4	765.7	4046.2	3824	7.648	2.06496	445741.6
622	500	5502	1514.3	868.9	7885.2	1813.5	1358.5	824.4	3996.4	3888.8	7.7776	2.099952	449630.4
623	500	5598.9	1538.9	706.3	7844.1	1631.3	1380.2	907.8	3919.3	3924.8	7.8496	2.119392	453555.2
624	500	5688.5	1554.3	611.7	7854.5	1681.9	1392.2	860.2	3934.3	3920.2	7.8404	2.116908	457475.4
625	500	5695.7	1545.2	644.6	7885.5	1718.9	1350.4	710.4	3779.7	4105.8	8.2116	2.217132	461581.2
626	500	5755.9	1554.8	644.3	7955	1665.6	1338.7	626.3	3630.6	4324.4	8.6488	2.335176	465905.6
627	500	5852.6	1559.8	611.9	8024.3	1656.7	1336.1	642.4	3635.2	4389.1	8.7782	2.370114	470294.7
628	500	5860.9	1555.2	707.8	8123.9	1627.8	1308.3	760.7	3696.8	4427.1	8.8542	2.390634	474721.8
629	500	5822.6	1550.6	826.9	8200.1	1676.9	1273.7	908	3858.6	4341.5	8.683	2.34441	479063.3
630	500	5803.7	1541.9	880.2	8225.8	1845	1268.7	853.7	3967.4	4258.4	8.5168	2.299536	483321.7
631	500	5828.9	1537.4	1011.9	8378.2	2000	1269.3	917.2	4186.5	4191.7	8.3834	2.263518	487513.4
632	500	5942.4	1540.6	1149.3	8632.3	2131.5	1267.8	1062.2	4461.5	4170.8	8.3416	2.252232	491684.2
633	500	5965.2	1548.7	1131.7	8645.6	2268.7	1292.6	1067.4	4628.7	4016.9	8.0338	2.169126	495701.1
634	500	5671.9	1558.7	632	7862.6	2097.8	1295.2	650.9	4043.9	3818.7	7.6374	2.062098	499519.8
635	500	5650.4	1551.9	624.1	7826.4	1909.1	1275.2	645.9	3830.2	3996.2	7.9924	2.157948	503516
636	500	5925	1544.4	1149.6	8619	2050.6	1261.5	1129.1	4441.2	4177.8	8.3556	2.256012	507693.8
637	500	6083.5	1544.4	1313.3	8941.2	2260.2	1349.6	1232.4	4842.2	4099	8.198	2.21346	511792.8
638	500	6206.3	1538.1	1224.3	8968.7	2385.9	1440.4	1198.7	5025	3943.7	7.8874	2.129598	515736.5
639	500	6246.9	1535.9	1000.2	8783	2456.1	1445.6	1026.7	4928.4	3854.6	7.7092	2.081484	519591.1
640	500	6248	1521.3	976.5	8745.8	2431.7	1465	931.1	4827.8	3918	7.836	2.11572	523509.1
641	500	6314.6	1523.7	956.5	8794.8	2425	1479.6	979.3	4883.9	3910.9	7.8218	2.111886	527420
642	500	6457.2	1536.5	894.6	8888.3	2510.2	1473.9	943.1	4927.2	3961.1	7.9222	2.138994	531381.1
643	500	6526.9	1535.6	923	8985.5	2485.2	1506.9	928.9	4921	4064.5	8.129	2.19483	535445.6
644	500	6524.8	1540.7	987.6	9053.1	2549.4	1521.9	987	5058.3	3994.8	7.9896	2.157192	539440.4
645	500	6626.5	1551.3	980.4	9158.2	2804.8	1495.7	963	5263.5	3894.7	7.7894	2.103138	543335.1
646	500	6836.5	1553.3	899.4	9289.2	2926.9	1476.5	1019.3	5422.7	3866.5	7.733	2.08791	547201.6
647	500	6837.4	1534.6	1022.4	9394.4	3015.2	1485.9	1150.6	5651.7	3742.7	7.4854	2.021058	550944.3
648	500	6683.1	1516.7	1068.3	9268.1	2942.4	1466.7	1058.7	5467.8	3800.3	7.6006	2.052162	554744.6
649	500	6527.6	1520.6	935.6	8983.8	2656.5	1451.7	923	5031.2	3952.6	7.9052	2.134404	558697.2
650	500	6163.7	1535	91.3	7790	2345.7	1449.6	845.6	4640.9	3149.1	6.2982	1.700514	561846.3
651	500	5679.6	1524.8	867	8071.4	1951.3	1349.4	814.8	4115.5	3955.9	7.9118	2.136186	565802.2
652	500	5324.3	1504.8	822.6	7651.7	1895.9	1290.4	959.4	4145.7	3506	7.012	1.89324	569308.2
653	500	5209.8	1507	836.5	7553.3	1929.4	1299.4	1010	4238.8	3314.5	6.629	1.78983	572622.7
654	500	5182.2	1505	901.3	7588.5	1727	1240.2	1025.9	3993.1	3595.4	7.1908	1.941516	576218.1
655	500	4942	1494.6	990.6	7427.2	1546.1	1122.4	1011.3	3679.8	3747.4	7.4948	2.023596	579965.5
656	500	4583.5	1485	1032.8	7101.3	1371.1	1007.2	1018.7	3397	3704.3	7.4086	2.000322	583669.8
657	500	4282.6	1476.9	1020.6	6780.1	1335.6	977.4	1080.4	3393.4	3386.7	6.7734	1.828818	587056.5
658	500	4164.8	1472.4	959.8	6597	1557.8	1023.3	1028.7	3609.8	2987.2	5.9744	1.613088	590043.7
659	500	4225.9	1436.7	1146.9	6809.5	1795.7	1007.4	987.6	3790.7	3018.8	6.0376	1.630152	593062.5
660	500	4265.4	1439.6	1349.6	7054.6	1872.6	897.2	1005.4	3775.2	3279.4	6.5588	1.770876	596341.9
661	500	4244.8	1459.3	1264.4	6968.5	1933.5	975	1075	3983.5	2985	5.97	1.6119	599326.9
662	500	4257.8	1448.3	1208.5	6914.6	1315.9	705.2	1216.3	3237.4	3677.2	7.3544	1.985688	603004.1
663	500	4039.1	1450.3	1056.1	6545.5	1033.5	609.3	1144.3	2787.1	3758.4	7.5168	2.029536	606762.5
664	500	3942.8	1422.6	804.1	6169.5	883.5	539.6	951.7	2374.8	3794.7	7.5894	2.049138	610557.2
665	500	4240.7	1405	771.1	6416.8	971	526.1	923.7	2420.8	3996	7.992	2.15784	614553.2
666	500	4399.6	1418	883.5	6701.1	1029.1	565.9	1100.7	2695.7	4005.4	8.0108	2.162916	618558.6
667	500	4393.5	1410.6	940.6	6744.7	887.8	609.1	1028	2524.9	4219.8	8.4396	2.278692	622778.4

TABLE 2. DREDGING QUANTITIES BY STATION, 1992

724	500	2219.4	1286.5	177.2	3683.1	739.6	818.7	145.6	1703.9	1979.2	3.9584	1.068768	791981.1
725	500	2358.1	1267.4	293.1	3918.6	758.7	848.1	346.9	1953.7	1964.9	3.9298	1.061046	793946
726	500	2269.6	1278.5	283.9	3832	858.7	877.4	315	2051.1	1780.9	3.5618	0.961686	795726.9
727	500	2336.3	1281.3	404.3	4021.9	979.6	823.5	374.1	2177.2	1844.7	3.6894	0.996138	797571.6
728	500	2551.1	1276.5	619.1	4446.7	1132.6	806.5	662.2	2601.3	1845.4	3.6908	0.996516	799417
729	500	2565.4	1304.4	581.1	4450.9	1211.5	799.1	639.3	2649.9	1801	3.602	0.97254	801218
730	500	2352	1297.8	368.5	4018.3	1098	765.9	454.4	2318.3	1700	3.4	0.918	802918
731	500	2210.9	1257.4	615.2	4083.5	1039.1	775	320.2	2134.3	1949.2	3.8984	1.052568	804867.2
732	500	2308	1236.5	487.8	4032.3	1160.9	874.1	493.3	2528.3	1504	3.008	0.81216	806371.2
733	500	2504.6	1250	602	4356.6	1273.5	935.9	667.8	2877.2	1479.4	2.9588	0.798876	807850.6
734	500	2758.3	1268.3	613.9	4640.5	1336.1	974.4	618.3	2928.8	1711.7	3.4234	0.924318	809562.3
735	500	2902.4	1280.6	543.9	4726.9	1481.5	1050.4	503.7	3035.6	1691.3	3.3826	0.913302	811253.6
736	500	2823.7	1274.8	463.3	4561.8	1496.1	1083.7	418	2997.8	1564	3.128	0.84456	812817.6
737	500	2694.3	1280.6	412.8	4387.7	1381.1	1036.1	386.3	2803.5	1584.2	3.1684	0.855468	814401.8
738	500	2706.7	1296.7	356.5	4359.9	1447	1009.3	390.6	2846.9	1513	3.026	0.81702	815914.8
739	500	2778	1283.9	373.5	4435.4	1559.1	1048	442.8	3049.9	1385.5	2.771	0.74817	817300.3
740	500	3063.5	1274.6	502.4	4840.5	1777.8	1091.9	448.9	3318.6	1521.9	3.0438	0.821826	818822.2
741	500	3381.5	1287.2	507	5175.7	1915.4	1122.4	435.7	3473.5	1702.2	3.4044	0.919188	820524.4
742	500	3509.6	1282.8	520	5312.4	2009.1	1146.1	455.9	3611.1	1701.3	3.4026	0.918702	822225.7
743	500	3677.8	1265.2	529.1	5472.1	2103	1152.6	432.8	3688.4	1783.7	3.5674	0.963198	824009.4
744	500	3821.1	1281.9	462.8	5565.8	2213.3	1172.6	407.8	3793.7	1772.1	3.5442	0.956934	825781.5
745	500	3795.6	1282	462.2	5539.8	2342.2	1198.5	530.6	4071.3	1468.5	2.937	0.79299	827250
746	500	3718.7	1256.7	477.2	5452.6	2394.8	1212	634.1	4240.9	1211.7	2.4234	0.654318	828461.7
747	500	3776.9	1272.4	446.7	5496	2543.1	1253.5	551.7	4348.3	1147.7	2.2954	0.619758	829609.4
748	500	3826.9	1280.2	448.9	5556	2568.3	1254.4	520.7	4343.4	1212.6	2.4252	0.654804	830822
749	500	3577	1253.7	516.3	5347	2225.4	1166.5	563	3954.9	1392.1	2.7842	0.751734	832214.1
750	500	2885.2	1230.9	465.4	4581.5	1637	1045.6	479.4	3162	1419.5	2.839	0.76653	833633.6
751	500	2326.3	1223.3	389.4	3939	1287.2	964.6	424.4	2676.2	1262.8	2.5256	0.681912	834896.4
752	500	2075.9	1227.2	382	3685.1	1264.8	989.6	396.5	2650.9	1034.2	2.0684	0.558468	835930.6
753	500	1901.3	1221.5	298.1	3420.9	1160	1007	300.9	2467.9	953	1.906	0.51462	836883.6
754	500	1896.9	1220.6	289.8	3407.3	1065.7	1022.4	314.3	2402.4	1004.9	2.0098	0.542646	837888.5
755	500	1779.1	1245	429.8	3453.9	980.9	1016.7	362	2359.6	1094.3	2.1886	0.590922	838982.8
756	500	1612.8	1259.1	430.9	3302.8	894.6	976.9	284.4	2155.9	1146.9	2.2938	0.619326	840129.7
757	500	1425	1218.7	393.9	3037.6	839.4	920.6	192.6	1952.6	1085	2.17	0.5859	841214.7
758	500	1151.5	1203.9	382.4	2737.8	813	899.6	173.7	1886.3	851.5	1.703	0.45981	842066.2
759	500	1049.8	1206.1	298.3	2554.2	813.9	945.9	164.6	1924.4	629.8	1.2596	0.340092	842696
760	500	1113.5	1180.7	359.8	2654	897.4	989.1	190.2	2076.7	577.3	1.1546	0.311742	843273.3
761	500	1038.5	1153.3	333.3	2600.1	1038.7	1047.2	220	2305.9	294.2	0.5884	0.158868	843567.5

TOTAL QUANTITY PLACED IN CONFINED DISPOSAL (STA 315 - 662) = 603004.1 CY
TOTAL QUANTITY PLACED IN OPEN-LAKE DISPOSAL (STA 663 -761) = 240563.4 CY
TOTAL = 843567.5 CY

TABLE 3. WAVE HEIGHT VERSUS PERCENT OCCURRENCE

*** NORTH SIDE OF CHANNEL ***

AZIMUTH DEG	PERCENT OCCURRENCE(X1000) OF WAVE HEIGHT (METERS) RANGE 0.0-0.24	0.24-0.49	.5-0.74	.75-0.99	1.-1.24	1.25-1.49	1.5-1.74	1.75-1.99	2-2.2	
0	753.00	1027.00	1555.00	91.00	494.00	58.00	23.00	4.00	0.00	
22.5	622.00	799.00	1146.00	425.00	285.00	46.00	32.00	9.00	1.00	
45	944.00	1029.00	1524.00	743.00	714.00	253.00	187.00	63.00	26.00	
247.5	1212.00	2168.00	3536.00	2257.00	722.00	102.00	53.00	1.00	0.00	
270	1508.00	2316.00	3245.00	1602.00	454.00	57.00	12.00	0.00	0.00	
292.5	924.00	1657.00	2522.00	1333.00	341.00	24.00	9.00	0.00	0.00	
315	825.00	1331.00	2303.00	1345.00	366.00	30.00	2.00	0.00	0.00	
337.5	606.00	941.00	1669.00	907.00	451.00	25.00	2.00	0.00	0.00	
SUM	7394.00	11268.00	17500.00	8703.00	8703.00	595.00	320.00	77.00	27.00	
									TOTAL=	54587.00
PERCENT	6.84	10.43	16.19	8.05	8.05	0.55	0.30	0.07	0.02	
									TOTAL =	50.52

*** SOUTH SIDE OF CHANNEL ***

AZIMUTH DEG	PERCENT OCCURRENCE(X1000) OF WAVE HEIGHT (METERS) RANGE 0.0-0.24	0.24-0.49	.5-0.74	.75-0.99	1.-1.24	1.25-1.49	1.5-1.74	1.75-1.99	2-2.2	
67.5	662.00	918.00	1629.00	958.00	1078.00	412.00	204.00	46.00	15.00	
90	873.00	1136.00	1640.00	733.00	669.00	187.00	92.00	7.00	3.00	
112.5	738.00	957.00	980.00	267.00	156.00	20.00	5.00	0.00	0.00	
135	995.00	1256.00	1388.00	437.00	201.00	20.00	1.00	0.00	0.00	
157.5	1030.00	1808.00	1797.00	454.00	127.00	8.00	0.00	0.00	0.00	
180	1512.00	2436.00	2733.00	808.00	97.00	3.00	2.00	0.00	0.00	
202.5	1160.00	2088.00	3070.00	1439.00	280.00	8.00	5.00	1.00	0.00	
225	1421.00	2055.00	3388.00	2236.00	742.00	75.00	24.00	0.00	0.00	
SUM	8391.00	12654.00	16625.00	7332.00	7332.00	733.00	333.00	54.00	18.00	
									TOTAL=	53472.00
PERCENT	7.77	11.71	15.39	6.79	6.79	0.68	0.31	0.05	0.02	
									TOTAL =	49.48

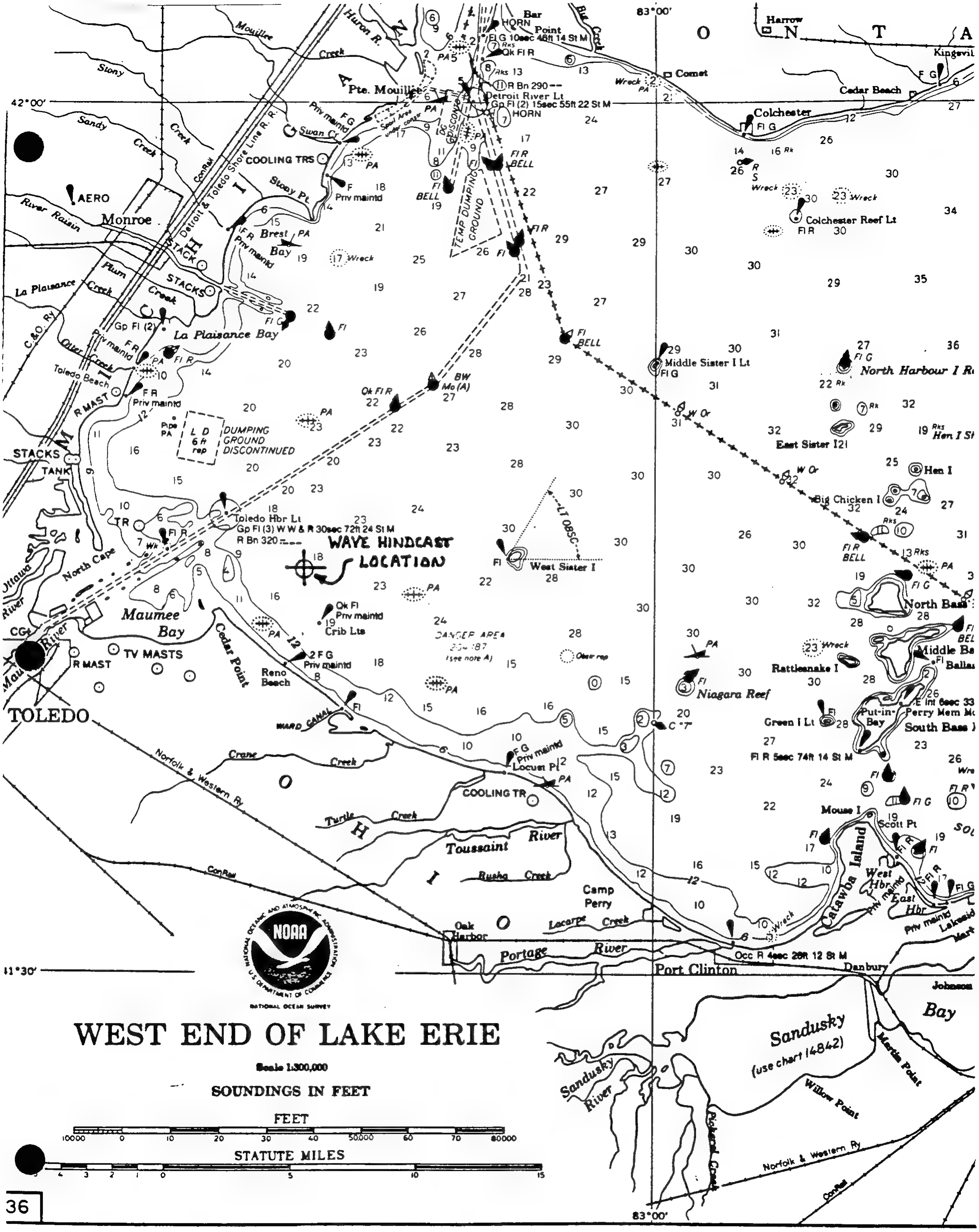


Figure A2. Wave Hindcast Location

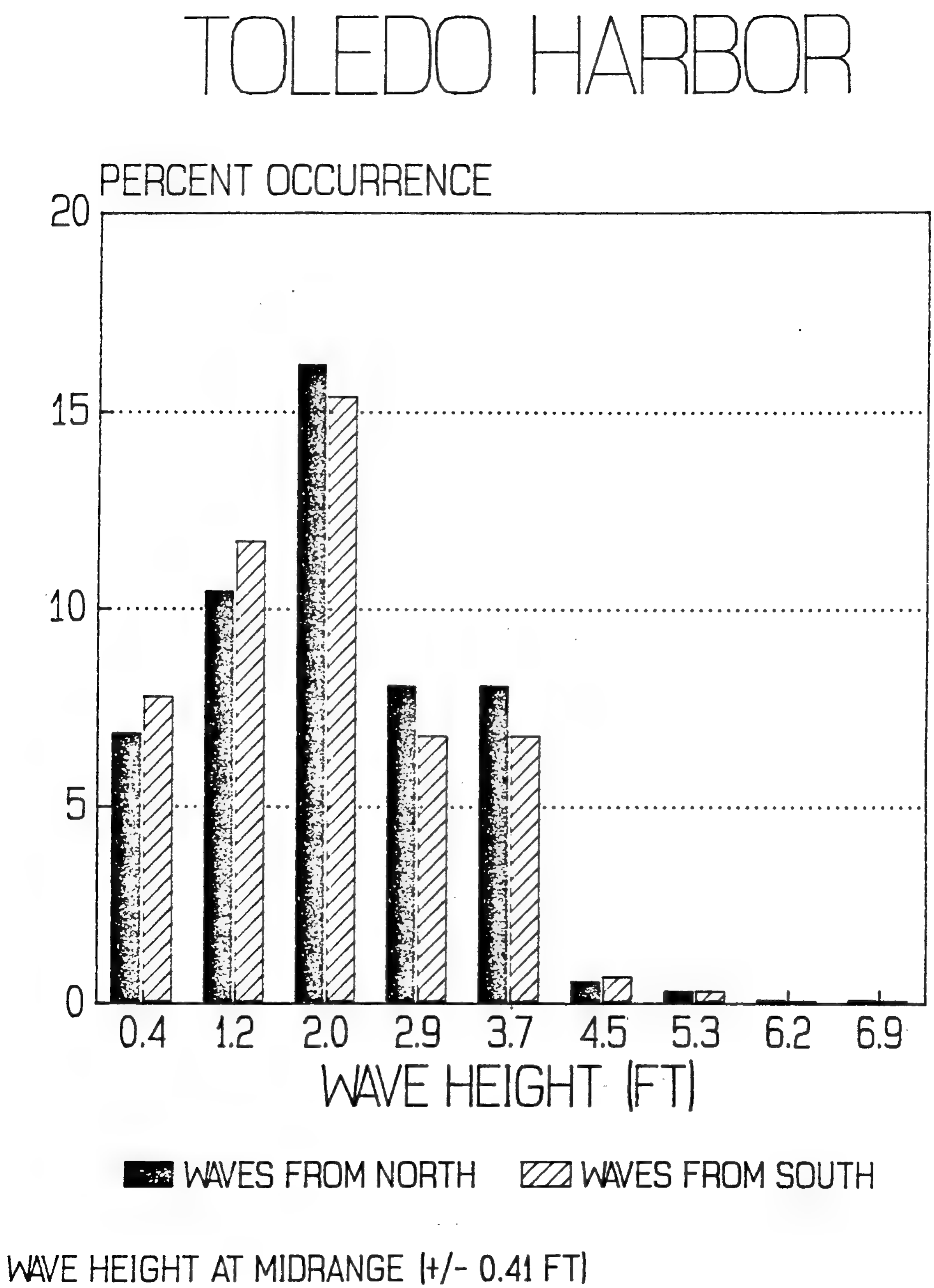


Figure A3 Wave Height vs Percent Occurrence

APPENDIX B

SEDIMENT SAMPLES DATA

Table 1 - Particle Size Analyses of Sediment Samples from Toledo Harbor Federal Navigation Channels and Open-Lake Discharge Site.

Sediment Sampling Site	Percent Retained						#200 Passed
	#8	#16	#30	#50	#100	#200	
D-4	<0.1	<0.1	<0.1	0.2	0.5	0.3	99.0
D-4 Rpt.	<0.1	<0.1	<0.1	0.1	0.3	1.4	98.2
D-3	<0.1	0.2	<0.1	0.4	0.6	2.2	96.6
D-2	<0.1	<0.1	<0.1	<0.1	0.5	1.0	98.5
D-1	0.1	0.1	0.1	0.8	2.0	5.4	91.5
L-16-M	<0.1	0.2	0.3	0.7	7.5	26.1	65.2
L-15-M	0.3	<0.1	<0.1	0.5	1.8	6.5	90.9
L-14-M	<0.1	<0.1	0.2	0.3	2.0	9.3	88.2
L-13-M	<0.1	<0.1	0.2	1.5	11.3	25.9	61.1
L-12-M	<0.1	0.2	<0.1	1.0	4.2	8.1	86.5
L-11-M	<0.1	0.2	0.3	1.4	6.0	8.2	83.9
L-10-M	<0.1	<0.1	<0.1	0.6	1.7	2.8	94.9
L-9-M	<0.1	<0.1	0.2	0.8	1.9	4.4	92.7
L-9-M Rpt.	<0.1	0.1	0.1	0.8	2.0	3.3	93.7
L-8-M	0.3	0.2	<0.1	0.7	2.2	5.1	91.5
L-7-M	0.2	<0.1	<0.1	0.7	1.5	6.9	90.7
L-6-M	0.1	0.3	0.3	0.7	1.1	3.5	94.0
L-5-M	0.8	0.3	0.5	0.8	1.9	6.7	89.0
L-4-M	<0.1	0.2	<0.1	0.5	0.5	1.9	96.9
L-3-M	<0.1	<0.1	<0.1	0.4	0.9	6.1	92.6
L-2-M	<0.1	<0.1	<0.1	0.3	0.6	2.7	96.4
L-1-M	<0.1	0.2	<0.1	0.2	0.6	1.1	97.9
O-M	<0.1	<0.1	<0.1	0.5	1.2	1.4	96.9
R-1-M	0.2	0.2	0.2	0.5	4.6	11.5	82.8
R-2-M	<0.1	<0.1	<0.1	0.4	1.7	1.4	96.5
R-3-M	<0.1	<0.1	<0.1	0.6	1.0	0.4	98.0
R-3-M Rpt.	<0.1	0.2	<0.1	1.1	1.3	0.5	96.9
R-4-M	1.0	0.7	1.5	6.2	7.1	2.9	80.6
R-5-M	7.3	2.6	2.9	5.8	4.8	3.1	73.5
R-6-M	7.2	2.7	2.3	2.8	9.0	8.3	67.7
R-7-M	<0.1	1.3	0.6	2.3	9.1	5.7	81.0

Table 2 - Bulk Inorganics Data on Sediment Samples Collected from Toledo Harbor Federal Navigation Channels and Open-Lake Discharge Site. All units are in ppm, unless otherwise indicated.

Sediment Sampling Site	Arsenic, Total	Barium, Total	Cadmium, Total	Chromium, Total	COD	Copper, Total	Cyanide, Total	Iron, Total	Lead, Total	Manganese, Total	Mercury, Total	Nickel, Total	Nitrate	Nitrogen, Ammonia	Oil/ Grease	Phenols, 4-AAP	Phosphorus, Total	Residue, T. Volatile, %	Residue, Total (TS), %	Total Kjeldahl N	Zinc, Total
	Inorganic Parameter																				
D-4	18	67	1	25	51000	31	<0.5	20300	29	400	0.1	29	<7	87	270	0.23	870	4.50	48.3	1320	110
D-3	22	79	3	48	110000	54	<0.6	26000	57	440	0.6	52	<12	89	400	0.24	890	6.60	33.2	1330	210
D-2	14	87	3	78	96000	58	<0.7	25500	69	500	0.5	56	<12	96	650	0.25	1100	5.57	31.0	1470	230
D-1	15	60	2	25	57000	37	<0.4	19300	35	360	0.2	33	<9	120	320	0.14	780	2.32	42.2	1080	130
L-16-M	9	29	2	32	34000	32	<0.3	12600	40	280	0.3	30	<6	21	880	0.26	570	2.51	59.4	472	130
L-15-M	16	49	3	49	72000	50	<0.5	17700	67	400	0.7	49	<9	50	830	0.13	830	5.12	38.5	952	200
L-14-M	13	42	3	38	53000	39	<0.5	14700	45	350	0.5	39	<9	42	520	0.14	710	4.81	42.2	852	160
L-13-M	9	31	2	28	38000	30	<0.4	11300	34	255	0.3	32	<7	37	250	0.16	560	3.23	54.0	649	110
L-12-M	19	60	3	37	76000	44	0.69	22300	59	400	0.4	42	<11	93	650	0.28	760	4.67	35.0	1050	160
L-11-M	18	60	2	31	74000	43	0.35	17600	48	400	0.3	38	<11	110	460	0.20	780	4.89	36.3	1440	160
L-10-M	21	69	2	30	93000	41	0.75	23300	38	440	0.3	39	<13	170	590	0.20	750	6.51	30.0	1470	150
L-9-M	17	53	2	19	67000	31	0.4	15300	23	450	0.3	28	<10	81	4300	0.18	700	4.77	38.2	1300	100
L-8-M	14	67	2	21	63000	29	0.23	18000	33	360	0.2	25	<7	59	620	0.10	760	3.88	48.0	1060	100
L-7-M	16	74	0.9	18	76000	28	0.52	20300	25	440	0.1	29	<10	120	420	0.19	750	5.52	39.3	1270	100
L-6-M	16	76	1	19	76000	27	0.6	18900	24	360	0.3	25	<9	160	330	0.23	770	5.58	44.4	1460	95
L-5-M	15	72	1	18	72000	29	0.56	14400	24	370	0.1	23	<8	140	30	0.13	830	6.11	46.2	1450	100
L-4-M	20	90	1	20	82000	32	0.48	23100	23	400	0.1	27	<10	110	340	0.20	840	5.98	38.9	1500	110
L-3-M	18	82	1	17	74000	29	0.47	16000	23	355	0.3	24	<9	160	380	<0.10	900	4.83	43.3	1810	98
L-2-M	20	92	2	23	86000	33	0.7	22900	29	470	0.1	30	<10	200	680	0.39	980	7.16	36.9	1420	120
L-1-M	22	110	2	24	97000	37	1.5	24900	26	460	0.1	32	<9	180	900	0.23	1100	7.58	37.6	1870	150
O-M	20	100	2	31	83000	38	0.52	27200	34	390	0.2	33	<9	270	1300	0.21	1200	6.63	42.3	1700	140
R-1-M	21	120	2	57	120000	52	1.58	31500	52	420	0.4	46	<10	870	3900	0.69	3500	8.84	36.8	2620	330
R-2-M	22	120	2	39	84000	39	0.67	29000	29	530	0.2	33	<10	210	1100	0.29	1400	7.45	37.0	1630	170
R-3-M	23	120	2	24	87000	36	0.98	30600	32	470	0.1	31	<10	150	710	0.16	1100	7.29	37.6	2860	160
R-4-M	12	70	2	14	46000	27	<0.3	13900	23	320	0.2	19	<6	88	340	0.13	840	4.29	54.7	1630	93
R-5-M	22	110	1	20	82000	40	0.5	24500	41	440	0.2	27	<9	150	980	0.17	1100	10.0	41.5	2750	150
R-6-M	18	82	0.9	16	58000	26	<0.6	19900	19	340	0.1	23	<7	91	270	0.13	820	4.25	46.6	1690	97
R-7-M	16	65	2	13	61000	23	<0.3	13200	16	335	0.2	23	<8	89	430	0.12	735	7.47	47.6	1980	82

Organochlorine Pesticide/PCB	Sediment Sampling Site																										
	D-1	D-2	D-3	D-4	L-1-M	L-2-M	L-3-M	L-4-M	L-5-M	L-6-M	L-7-M	L-8-M	L-9-M	L-10-M	L-11-M	L-12-M	L-13-M	L-14-M	L-15-M	L-16-M	O-M	R-1-M	R-2-M	R-3-M	R-4-M	R-5-M	R-6-M	R-7-M
alpha-Endosulfan	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04
beta-Endosulfan	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04
Endosulfan Sulfate	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06
alpha-BHC	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02
beta-BHC	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02
gamma-BHC (Lindane)	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02
delta-BHC	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02
Aldrin	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.02
Dieldrin	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04
4,4'-DDE	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04
4,4'-DDD	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04
4,4'-DDT	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04
Endrin	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06
Endrin Aldehyde	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06
Heptachlor	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04	<0.02	<0.02	<0.02	<0.02	<0.04
Heptachlor Epoxide	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06	<0.03	<0.03	<0.03	<0.03	<0.06
Chlordane	<0.10	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.20	<0.10	<0.10	<0.10	<0.10	<0.20
Toxaphene	<0.50	<0.50	<1.00	<0.50	<0.50	<0.50	<0.50	<1.00	<0.50	<0.50	<0.50	<0.50	<1.00	<0.50	<0.50	<0.50	<0.50	<1.00	<0.50	<0.50	<0.50	<0.50	<1.00	<0.50	<0.50	<0.50	<0.50	<1.00
Aroclor 1016	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1221	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1232	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1242	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1248	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1254	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1260	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Table 4 - Bulk Purgeable Halocarbon Analyses Conducted on Sediment Samples from Toledo Harbor Federal Navigation Channels and Open-Lake Discharge Site. All units are in ppm.

Purgeable Halocarbon	Sediment Sampling Site																											
	D-1	D-2	D-3	D-6	L-1-M	L-2-M	L-3-M	L-4-M	L-5-M	L-6-M	L-7-M	L-8-M	L-9-M	L-10-M	L-11-M	L-12-M	L-13-M	L-14-M	L-15-M	L-16-M	O-M	R-1-M	R-2-M	R-3-M	R-4-M	R-5-M	R-6-M	R-7-M
Bromoform	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Bromodichloromethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Carbon Tetrachloride	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chlorobenzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chloroethane	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
2-Chloroethyl Vinyl Ether	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chloroform	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Dibromochloromethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,2-Dichlorobenzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,3-Dichlorobenzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,4-Dichlorobenzene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1-Dichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,2-Dichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1-Dichloroethene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,2-Dichloropropane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
trans-1,3-Dichloropropene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Methyl Chloride	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
1,1,2,2-Tetrachloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Tetrachloroethene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
trans-1,2-Dichloroethene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,1-Trichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
1,1,2-Trichloroethane	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Trichloroethene	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Trichlorofluoromethane	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Vinyl Chloride	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020

Table 3 - Bulk PAH and Phthalate Esters Analyses Conducted on Sediment Samples from Toledo Harbor Federal Navigation Channels and Open-Lake Discharge Site. All units are in ppm.

Sediment Sampling Site

PAH/Phthalate Esters	D-1	D-2	D-3	D-4	L-1-M	L-2-M	L-3-M	L-4-M	L-5-M	L-6-M	L-7-M	L-8-M	L-9-M	L-10-M
Acenaphthene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Acenaphthylene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Anthracene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Benzo(a)Anthracene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Benzo(a)Phrene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Benzo(b)Fluoranthene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Benzo(ghi)Perylene	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Benzo(k)Fluoranthene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chrysene	<0.20	<0.20	<0.20	<0.20	1.05	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.38	<0.20	<0.20
Dibenzo(a,h)Anthracene	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Fluoranthene	<0.30	<0.30	<0.30	<0.30	0.41	0.46	0.40	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Fluorene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Indeno(1,2,3-cd)Pyrene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Naphtalene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Phenanthrene	0.17	0.16	0.16	0.24	0.67	0.53	0.38	0.19	0.25	0.13	0.15	0.22	<0.10	0.12
Pyrene	0.45	0.37	0.33	0.61	0.98	0.87	1.06	0.38	0.48	0.31	0.53	0.55	0.41	0.28
Bis(2-ethylhexyl)Phthalate	<0.30	0.83	0.85	0.49	1.76	<0.30	2.09	0.78	1.20	1.09	<0.30	<0.30	<0.30	<0.30
Butylbenzyl Phthalate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Di-n-butyl Phthalate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Diethyl Phthalate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Dimethyl Phthalate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Di-n-octyl Phthalate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30

PAH/Phthalate Esters	L-11-M	L-12-M	L-13-M	L-14-M	L-15-M	L-16-M	O-M	R-1-M	R-2-M	R-3-M	R-4-M	R-5-M	R-6-M	R-7-M
Acenaphthene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.39	<0.20	<0.20	<0.20	<0.20	<0.20
Acenaphthylene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Anthracene	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.12	<0.10	0.47	<0.10	<0.10	0.40	0.40	<0.10
Benzo(a)Anthracene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	1.21	<0.30	<0.30	1.01	<0.30	<0.30
Benzo(a)Phrene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0.65	<0.30	<0.30	<0.30	<0.30	<0.30
Benzo(b)Fluoranthene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Benzo(ghi)Perylene	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Benzo(k)Fluoranthene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Chrysene	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	1.67	1.45	<0.20	<0.20	1.27	<0.20	<0.20
Dibenzo(a,h)Anthracene	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Fluoranthene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0.67	1.99	2.73	0.88	0.95	1.96	0.75	0.33
Fluorene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0.71	<0.30	<0.30	0.33	<0.30	<0.30
Indeno(1,2,3-cd)Pyrene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Naphtalene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0.65	0.57	0.61	<0.30	<0.30	<0.30	<0.30	<0.30
Phenanthrene	0.14	<0.10	<0.10	0.16	<0.10	<0.10	0.77	1.57	2.99	0.81	0.85	1.53	0.44	0.26
Pyrene	0.42	<0.20	<0.20	<0.20	0.24	<0.20	1.20	2.44	2.24	1.50	1.98	2.40	0.78	0.36
Bis(2-ethylhexyl)Phthalate	<0.30	<0.30	0.60	<0.30	0.93	<0.30	3.05	17.8	3.82	2.34	<0.30	1.88	<0.30	0.83
Butylbenzyl Phthalate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Di-n-butyl Phthalate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Diethyl Phthalate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Dimethyl Phthalate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Di-n-octyl Phthalate	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	1.79	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30

Table 6 - Elutriate Test Data on Sediment Samples Collected from Toledo Harbor Federal Navigation Channels and Open-Lake Discharge Site.

Sediment Sampling Site	Inorganic Parameter																	
	Arsenic, Total UG/L	Barium, Total UG/L	Cadmium, Total UG/L	Chromium, Total UG/L	Copper, Total UG/L	Cyanide, Total MG/L	Iron, Total UG/L	Lead, Total UG/L	Manganese, Total UG/L	Mercury, Total UG/L	Nickel, Total UG/L	Nitrate MG/L	Nitrogen, Ammonia MG/L	Oil/ Grease MG/L	Phenols, 4-AAP MG/L	Phosphorus, Total MG/L	Total Kjeldahl N MG/L	Zinc, Total UG/L
D-4	8	170	<1	<30	<20	0.01	160	<5	420	<2.0	<30	0.14	2.53	24	<0.01	<0.10	3.00	55
D-3	<5	200	<1	<30	<20	<0.01	200	<5	540	2.0	<30	0.11	1.98	1	<0.01	<0.10	2.04	47
D-2	<5	170	<1	<30	<20	<0.01	220	<5	660	<2.0	<30	<0.08	1.68	5	<0.01	<0.10	1.71	41
D-1	5	180	<1	<30	<20	<0.01	220	<5	640	2.0	<37	<0.08	4.11	<1	<0.01	<0.10	4.22	40
L-16-N	<5	180	<1	<30	<20	<0.01	160	<5	470	<2.0	<30	0.11	1.33	1	<0.01	<0.10	1.50	35
L-15-N	<5	170	<1	<30	<20	<0.01	310	<5	540	<2.0	<30	<0.08	1.80	<1	<0.01	<0.10	1.81	33
L-14-N	<5	190	<1	<30	<20	<0.01	280	<5	720	<2.0	<30	<0.08	1.50	1	<0.01	<0.10	1.90	42
L-13-N	<5	190	<1	<30	<20	<0.01	130	<5	530	<2.0	<30	<0.08	1.59	2	<0.01	<0.10	1.78	35
L-13-N Rpt.	<5	170	<1	<30	<20	<0.01	160	<5	600	<2.0	<30	<0.08	1.57	2	<0.01	<0.10	1.63	29
BLANK	<5	170	<1	<30	<20	<0.01	56	<5	91	2.0	<30	<0.08	<0.02	<1	<0.01	<0.10	<0.10	<20
L-12-N	<5	54	<1	<30	<20	<0.01	77	<5	99	<2.0	<30	0.14	2.21	<1	<0.01	<0.10	2.56	<20
L-11-N	<5	150	<1	<30	<20	<0.01	85	<5	360	<2.0	<30	<0.08	3.25	1	<0.01	<0.10	3.76	25
L-10-N	<5	180	<1	<30	<20	<0.01	110	<5	1000	3.0	<30	<0.08	5.11	2	<0.01	<0.10	5.54	41
L-9-N	<5	190	<1	<30	<20	<0.01	110	<5	590	<2.0	<30	<0.08	2.93	<1	<0.01	<0.10	3.23	34
L-8-N	<5	190	<1	<31	<20	<0.01	85	<5	450	2.0	<31	<0.08	1.77	3	<0.01	<0.10	1.89	23
L-7-N	<5	240	<1	<30	<20	<0.01	150	<5	1200	2.0	<30	<0.08	5.92	<1	<0.01	<0.10	7.02	53
L-6-N	<5	180	<1	<30	<20	<0.01	130	<5	980	<2.0	<30	<0.08	8.33	8	<0.01	<0.10	8.79	41
L-5-N	5	180	<1	<30	<20	<0.01	130	<5	390	4.0	<30	0.18	6.55	<1	<0.01	<0.10	6.74	37
L-4-N	11	190	<1	<30	<20	<0.01	140	<5	1300	<2.0	<30	<0.08	6.11	<1	<0.01	<0.10	6.20	54
L-3-N	6	190	<1	<30	<20	<0.01	110	<5	1100	<2.0	<30	0.11	6.80	1	<0.01	<0.10	7.56	46
L-3-N Rpt.	7	250	<1	<30	<20	<0.01	120	<5	1100	<2.0	<30	0.11	7.44	<1	<0.01	<0.10	8.30	61
L-2-N	7	170	<1	<30	<20	<0.01	250	<5	1400	11.0	<30	<0.08	8.38	1	<0.01	<0.10	8.80	34
L-1-N	8	190	<1	<30	<20	<0.01	400	<5	1400	3.0	<30	<0.08	8.02	<1	<0.01	<0.10	8.60	37
O-N	5	190	<1	<30	<20	<0.01	110	<5	410	<2.0	<30	0.43	8.03	<1	<0.01	<0.10	8.50	41
R-1-N	8	230	<1	<30	<20	<0.01	450	<5	690	<2.0	<30	<0.08	27.5	4	<0.01	<0.10	30.6	51
R-2-N	11	150	<1	<30	<20	<0.01	110	<5	580	<2.0	<30	0.36	6.70	4	<0.01	<0.10	7.20	27
R-3-N	11	180	<1	<30	<20	<0.01	230	<5	1200	<2.0	<30	0.14	6.37	<1	<0.01	0.11	6.60	29
R-4-N	14	200	<1	<30	<20	<0.01	110	<5	830	22	<30	0.39	4.04	<1	<0.01	0.18	4.80	44
R-5-N	18	200	<1	<30	<20	<0.01	100	<5	640	4.0	<30	0.29	5.14	1	<0.01	0.23	5.40	52
R-6-N	12	140	<1	<30	<20	<0.01	92	<5	670	3.0	<30	0.32	3.49	<1	<0.01	<0.10	3.70	28
R-7-N	16	190	<1	<30	<20	<0.01	180	<5	1000	<2.0	<30	0.11	4.41	1	<0.01	0.11	5.30	46
R-7-N Rpt.	12	190	<1	<30	<20	<0.01	110	<5	1100	<2.0	<30	0.18	4.10	<1	<0.01	<0.10	5.00	47

Table 7 - Depth Intervals (in Inches) of Soil Samples Collected in Toledo Harbor CDFs.

Soil Sampling Site	Sample Number						
	1	2	3	4	5	6	7
I	0-3[1]	12-38	38-72	72-114	114-156	156-186	*
II	10[1]	*	12-60	70-126	126-156	156	--
III	0-3	12-70	70-180	180-220	--	--	--
IV	0-6[1]	6-72	72-128	*	--	--	--
V	0-12	--	--	--	--	--	--

1 Not Analyzed.

* One gallon sample obtained from surface to approximately one foot of depth, and subjected to column leach testing.

-- No sample obtained.

Table 8 - Particle Size Analyses of Soil Samples Collected from Toledo Harbor Dredged Material CDFs.

Soil Sampling Site	Percent Retained						#200 Passed
	#8	#16	#30	#50	#100	#200	
I-2	<1.0	<1.0	<1.0	<1.0	<1.0	4.2	95.4
I-3	<1.0	<1.0	<1.0	<1.0	<1.2	6.1	91.4
I-4	<1.0	1.0	<1.0	<1.0	<1.0	4.4	94.5
I-5	<0.5	4.7	<0.5	0.5	1.6	4.7	92.2
I-6	<0.5	<0.5	<0.5	0.5	0.9	2.0	96.1
II-3	<0.4	0.7	0.4	<0.4	0.4	1.7	95.8
II-4	<0.5	<0.5	<0.5	<0.5	<0.5	1.7	97.0
II-5	<0.6	<0.6	<0.6	<0.6	0.8	4.5	94.0
III-1	<0.8	<0.8	<0.8	<0.8	<0.8	4.2	96.8
III-2	<0.7	<0.7	<0.7	<0.7	<0.7	1.8	96.9
III-3	<0.6	<0.6	<0.6	<0.6	<0.6	2.0	97.9
III-4	<0.7	<0.7	<0.7	<0.7	<0.7	2.4	98.0
IV-2	<0.6	2.8	3.4	7.5	14.7	11.3	61.0
IV-3	3.7	7.0	8.1	18.3	34.2	14.4	13.1
II-2	<0.3	<0.3	<0.3	0.8	0.5	0.6	97.3
II-2 Replicate	<0.3	<0.3	<0.3	0.6	0.4	2.4	97.4
V-1	<0.3	<0.3	<0.3	0.4	<0.3	1.4	98.5
IV-4	8.6	7.5	14.0	25.0	31.4	8.7	4.1
IV-4 Replicate	6.6	9.9	20.2	26.6	24.5	6.9	5.2
IV-7	<0.2	0.2	0.6	1.4	0.5	1.6	97.2

Table 9 - Bulk Inorganic Analyses Conducted on Soil Samples Collected from the Toledo Harbor CDFs. All data are reported in ppm, unless otherwise indicated.

Inorganic Parameter	Soil Sampling Site																
	I-2	I-3	I-4	I-5	I-6	II-3	II-4	II-5	III-1	III-2	III-3	III-4	IV-2	IV-3	II-2	V-1	IV-4	I-7
Total Solids, %	73.0	74.3	69.7	71.3	65.3	64.3	64.6	63.5	74.7	69.9	66.2	65.5	71.2	72.6	70.5	48.1	84.7	75.7
% Volatile Solids, %	5.98	5.03	5.01	5.20	5.78	5.70	5.56	5.32	5.07	6.11	4.39	4.63	2.74	3.20	7.13	5.78	1.39	6.72
Arsenic	7.5	4.1	6.5	4.0	9.1	5.9	10.6	8.7	7.0	4.9	13.4	9.3	4.2	2.9	13.7	4.9	2.3	5.6
Barium	135	110	136	127	139	138	132	145	130	185	135	112	94	92	195	160	29	180
Cadmium	4.1	2.7	4.6	3.4	4.3	3.4	4.0	4.4	2.5	4.3	3.3	2.1	1.1	1.5	5.2	2.3	4.5	4.3
Chromium	48	31	51	35	41	43	44	53	34	45	38	24	19	23	67	28	7	58
Copper	44	35	49	39	50	43	45	52	49	44	45	34	25	34	59	34	10	49
Lead	58	35	58	39	65	41	43	49	43	41	42	27	19	33	62	27	7	47
Mercury	0.25	0.25	0.28	0.24	0.39	0.33	0.28	0.36	0.28	0.28	0.32	0.20	0.12	0.24	0.48	0.24	<0.12	0.36
Nickel	50	42	47	40	44	47	48	50	44	51	47	36	30	35	56	40	14	50
Zinc	195	140	190	140	200	170	170	190	160	190	155	130	98	120	260	150	36	210
Iron	22,800	17,400	20,900	17,400	24,100	22,800	22,300	21,300	20,900	23,800	21,000	17,500	16,400	16,300	27,300	22,600	6,700	25,300
Manganese	345	320	380	350	390	350	380	370	370	370	371	360	290	280	380	380	150	420
Ammonia N	6.6	21.8	84.8	64.9	169	125	297	263	<1.6	8.5	80.7	89.8	61.0	30.0	3.8	127	16.2	3.1
TKN	1,270	624	4.6	644	669	817	1,520	1,080	880	878	580	663	822	395	514	1,710	92.5	273
Total P	1,600	950	1,580	1,110	1,250	1,260	1,260	1,470	1,320	1,245	1,310	810	940	780	1,980	1,230	350	1,440

Table 10 - Bulk Pesticide, PCB, Oil/Grease Analyses Conducted on Soil Samples Collected in Toledo Harbor CDFs. All data are reported in ppm.

Pesticide/PCB/ Oil/Grease	Soil Sampling Site I-2	I-3	I-4	I-5	I-6	II-3	II-4	II-5	III-1	III-2	III-3	III-4	IV-2	IV-3	I-1	II-2	IV-4	V-1
beta-Endosulfan	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
alpha-Endosulfan	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Endosulfan Sulfate	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
alpha-BHC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
beta-BHC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
gamma-BHC (Lindane)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
delta-BHC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dieldrin	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
4,4'-DDE	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
4,4'-DDD	0.04	<0.02	0.07	0.07	0.06	0.14	0.12	0.04	<0.02	<0.02	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
4,4'-DDT	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Endrin	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Endrin Aldehyde	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.04	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Heptachlor	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Heptachlor Epoxide	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Chlordane	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Toxaphene	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Methoxychlor	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Mirex	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1016	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1221	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1232	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1242	0.40	0.80	0.90	0.40	0.40	0.50	1.50	1.00	0.60	2.30	0.40	0.40	0.30	0.20	0.40	0.40	<0.10	0.80
Aroclor 1248	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1254	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Aroclor 1260	0.60	0.30	0.60	0.40	0.40	1.00	1.60	0.60	0.50	2.60	0.40	0.40	0.10	<0.10	0.60	0.50	<0.10	0.30
Oil & Grease	1550	887	1410	1620	2260	1140	2920	2780	704	2370	1340	1340	422	298	1600	2440	260	1340

Table 11 - Bulk PAH Analyses Conducted on Soil Samples Collected in Toledo Harbor CDFs. All data are reported in ppm.

	Soil Sampling Site																	
PAH	I-2	I-3	I-4	I-5	I-6	II-3	II-4	II-5	III-1	III-2	III-3	III-4	IV-2	IV-3	I-1	II-2	IV-4	
Phenanthrene	0.83	<0.27	1.10	0.52	<0.27	<0.27	1.5	1.6	0.74	<0.27	<0.27	<0.27	1.90	<0.27	<0.27	<0.27	<0.27	<0
Anthracene	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	1.80	<0.13	<0.13	<0.13	<0.13	<0
Fluoranthene	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<1.10	<0
Pyrene	<1.47	<1.47	3.46	<1.47	<1.47	<1.47	7.52	5.86	<1.47	<1.47	<1.47	<1.47	<1.47	<1.47	<1.47	<1.47	<1.47	<1
Benzo(a)Anthracene	1.20	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<0
Chrysene	1.92	1.20	3.40	1.45	1.68	<0.42	4.10	3.9	<0.42	<0.42	<0.42	<0.42	1.45	<0.42	<0.42	<0.42	<0.42	<0
Benzo(b)Fluoranthene	<0.44	<0.44	1.90	<0.44	<0.44	<0.44	2.1	1.6	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<0
Benzo(k)Fluoranthene	<0.59	<0.59	<0.59	<0.59	0.64	<0.59	<0.59	<0.59	<0.59	<0.59	<0.59	<0.59	<0.59	<0.59	<0.59	<0.59	<0.59	<0
Benzo(a)Pyrene	<0.42	<0.42	<0.42	<0.42	<0.42	<0.42	1.3	1.7	<0.42	<0.42	<0.42	<0.42	<0.42	<0.42	<0.42	<0.42	<0.42	<0
Dibenzo(a,h)Anthracene	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2.10	<2
Indeno(1,2,3-cd)Pyrene	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1.48	<1
Benzo(ghi)Perylene	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<0

Table 12 - Column Leach Testing Data on Soil Samples Collected from the Toledo Harbor CDFs - Sampling Interval No. 1.

Analyte	Soil Sampling Site I-7		II-2		IV-4	
Leachate Collected, ml	1200		350		850	
pH, S.U.	7.1		6.6		7.1	
Conductivity, umho	693		1,100		506	
T. Solids, mg/l	577	(453)*	897	(223)	293	(145)
T. Volatile solids, mg/l	100	(78)	233	(58)	104	(52)
Susp. Solids, mg/l	<1	(<0.7)	<1	(<0.2)	<1	(<0.5)
Ammonia N, mg/l	<0.1	(<0.078)	<0.1	(<0.025)	10.1	(5.01)
TKN, mg/l	1.50	(1.18)	3.36	(0.83)	14.0	(6.94)
Total P, mg/l	0.32	(0.25)	0.46	(0.11)	0.85	(0.42)
Arsenic, ug/l	28	(0.022)	17	(0.042)	22	(0.011)
Barium, ug/l	<100	(<0.078)	<100	(<0.025)	100	(<0.050)
Cadmium, ug/l	11	(0.0086)	7	(0.002)	1	(0.001)
Chromium, ug/l	8	(0.006)	<20	(<0.005)	5	(0.002)
Copper, ug/l	38	(0.030)	60	(0.015)	30	(0.015)
Lead, ug/l	<5	(<0.004)	<30	(<0.007)	5	(0.002)
Mercury, ug/l	<0.3	(<0.0002)	<0.4	(<0.0001)	0.3	(<0.0001)
Nickel, ug/l	45	(0.035)	80	(0.020)	35	(0.017)
Zinc, ug/l	28	(0.022)	50	(0.012)	38	(0.019)
Iron, ug/l	1940	(1.52)	240	(0.060)	2590	(1.28)
Manganese, ug/l	470	(0.37)	290	(0.072)	290	(0.14)

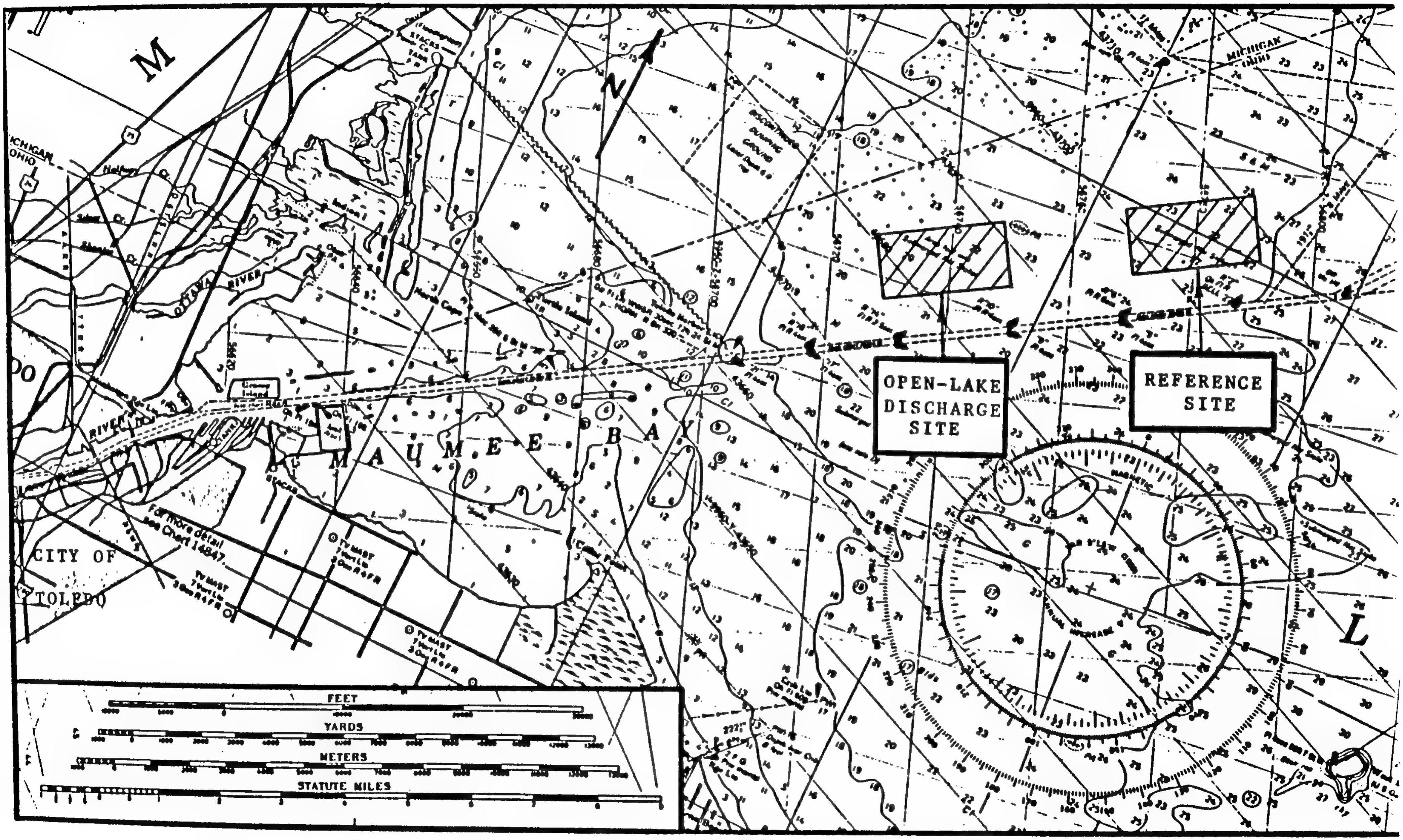
* Numbers in parentheses represent mg of leached material per kg of sediment (dry) in column.

Table 13 - Column Leach Testing Data on Soil Samples Collected from the Toledo Harbor CDFs - Sampling Interval No. 2.

Analyte	Soil Sampling Site I-7		II-2		IV-4	
Leachate Collected, ml	925		600		1,000	
pH, S.U.	6.9		7.0		6.6	
Conductivity, umho	452		933		210	
T. Solids, mg/l	250	(151)*	708	(301)	96	(56)
T. Volatile solids, mg/l	60	(36)	448	(191)	36	(21)
Susp. Solids, mg/l	4	(2)	<2	(<0.9)	46	(27)
Ammonia N, mg/l	<0.1	(<0.06)	<0.1	(<0.04)	2.63	(1.53)
TKN, mg/l	0.88	(0.53)	1.13	(0.48)	4.38	(2.56)
Total P, mg/l	0.45	(0.27)	0.79	(0.34)	1.52	(0.89)
Arsenic, ug/l	12	(0.0073)	13	(0.0055)	13	(0.0076)
Barium, ug/l	<100	(<0.06)	<100	(<0.04)	<100	(<0.06)
Cadmium, ug/l	12	(0.0073)	13	(0.0055)	13	(0.0076)
Chromium, ug/l	10	(0.006)	13	(0.0055)	13	(0.0076)
Copper, ug/l	150	(0.091)	150	(0.063)	130	(0.076)
Lead, ug/l	210	(0.13)	230	(0.098)	280	(0.16)
Mercury, ug/l	<0.3	(<0.0002)	<0.3	(<0.0001)	<0.3	(<0.0002)
Nickel, ug/l	95	(0.057)	98	(0.042)	83	(0.048)
Zinc, ug/l	40	(0.020)	45	(0.019)	58	(0.034)
Iron, ug/l	1,100	(0.665)	620	(0.26)	1,500	(0.875)
Manganese, ug/l	630	(0.38)	860	(0.37)	320	(0.19)

* Numbers in parentheses represent mg of leached material per kg of sediment (dry) in column.

Figure 16 Toledo Harbor, Lucas County, Ohio - Existing open-lake discharge site for dredged material (the open-lake reference site is for comparison purposes only).



APPENDIX C

SEDIMENT LOAD REDUCTION DETAILS

I. Introduction

The Maumee River Basin drains 4,230,000 acres from three states. Agricultural and forestland comprise the majority of land use in the basin. There are approximately 3,300,000 acres of cropland, 50,000 acres of pasture land, 100,000 acres of farmsteads, and 300,000 acres of forestland in the basin. The remainder of the acreage consists of urban and built-up land and land devoted to miscellaneous and rural transportation uses.

II. Physiology and Geology and Soils

The basin is shaped like a round saucer with flat lake plains in the low center, sloping till plains around the higher periphery, and beach ridges scattered in between. The basin lies in the glaciated lake and till plains of the central lowlands physiographic province. The central and lower portion of the basin is in Major Land Resource Area (MLRA) 99, Erie Huron Plain. This section has a nearly flat to gently undulating surface veneered with lacustrine (lake) deposits. Relief is generally 5 to 10 feet, but in some areas near streams it may reach 20 feet. The periphery of the basin is in MLRA 111, Indiana and Ohio Till Plain. Till plain land is relatively flat to undulating and characterized by broken ridges (end moraines) roughly paralleling the shore of Lake Erie.

Bedrock exposures are rare in the basin. Streams of the Maumee River system are mostly of flat gradient, except for the St. Joseph River headwaters in Hillsdale County, Michigan. This stream flows southwest through Williams County, Ohio, to Fort Wayne in Allen County, Indiana, where it joins stream flow from the St. Marys River flowing northwest to form the Maumee River. The Maumee then flows northeast to Lake Erie at Toledo. Two other streams join the Maumee River at Defiance. The Tiffin River flows south from Hillsdale and Lenawee Counties, Michigan, and the Auglaize-Blanchard River systems which drain much of the southern portion of the Maumee Basin.

The Maumee River from Fort Wayne to Toledo has an average slope of 1.3 feet per mile; St. Marys 2.8 ft/mi; St. Joseph 1.6; Tiffin 1.2; Auglaize 3.2; Little Auglaize 2.5; and Blanchard 0.9 feet per mile. Some of the headwater streams have a fall of 10 feet per mile.

The soils in the Maumee River Basin are predominantly nearly level to gently sloping. They are very poorly to somewhat poorly drained, moderately fine to fine textured, and formed in lacustrine and till material. In local areas throughout the basin, there are better drained soils, such as sloping soils and gravelly and sandy soils, and a few bog soil areas. Alluvial soils in the basin are mostly dark colored and very poorly drained.

V. Transport of Eroded Material

Only a portion of the soil that is eroded within a basin is transported to the mouth of the basin. Some soil remains in upland fields or is trapped in floodplains, channels, lakes, and ponds. The Waterville Gauge on the Maumee River at Waterville, Ohio, has measured an average annual suspended sediment load of 1,300,000 tons. Since 1951,[1/] this load represents most of the sediment that enters Toledo Harbor, but is only 12 percent of the 10,259,000 tons of soil that has eroded within the basin annually. This percentage is termed a delivery rate or delivery ratio.

A sediment rating curve was developed for discharge and sediment load data from the Waterville Gauge. This relationship shows that the sediment load increases in linear proportion to water discharge. This relationship is further demonstrated by plotting annual sediment load against average annual water discharge as displayed in the graph "Water and Sediment Discharge for Maumee River Basin."[2/]

The "Sediment Discharge Ratio A/B" graph is an attempt to neutralize the impact of water discharge cycles in order to isolate cycles of sediment availability. The graph is elevated for periods 1951-1957 and 1972-1976. These elevations may correspond to post war changes in agricultural management and later to the row crop rotation which was induced by commodity price increases and extensive use of agricultural chemicals (see section entitled "Recent History of Maumee Basin").

VI. Fluvial Sedimentation Dynamics in the Toledo Harbor

As stated previously in this document, approximately 1,268,000 tons of sediment annually passes the USGS stream gauge at Waterville, Ohio. A portion of this material is deposited in the ship channel each year. The U.S. Army Corps of Engineers reports that an average of 780,000 cubic yards of sediment are dredged from the ship channel annually.[3/]

Available data on situ sediments in the Maumee Basin indicate average densities of approximately 40 pounds per cubic foot.[4/] At this density, the dredged mass would average approximately 421,200 tons annually, or 33 percent of the sediment that passes the Waterville Stream Gauge. The value of 33 percent is the average sediment trap efficiency of the ship channel. This value was also evaluated by imperical methods using sediment type, ship channel capacity, and average annual water volume discharged into the channel. These calculations indicate a trap efficiency of 32 percent.[5/]

1/ U.S Geological Survey Data. 1992.
2/ Data was not obtained in water years 1985, 86, 87, 88, and 89.
3/ U.S. Army Corps of Engineers, Buffalo District. "Environmental Assessment and Finding of No Significant Impact - Operations and Maintenance for Toledo Harbor, Lucas County, Ohio." February 1989.
4/ USDA, Soil Conservation Service. "Impact of Erosion and Conservation on Lakes in Ohio." August 1990.
5/ USDA, Soil Conservation Service. National Engineering Handbook, Section 3, Sedimentation.

VII. Methodology of Analysis Used to Determine Sedimentation Reductions in the Toledo Harbor Due to Erosion Reductions on Basin Soils

The reduction of soil erosion on the land in the basin will reduce the amount of sediment delivered to the harbor.

This analysis utilizes the following parameters:

a. Soil loss reduction in tons per year.[1]

b. Basin delivery rate (approximately 10 percent).

c. Ship channel trap efficiency (approximately 32 percent).

The relationship is:
Annual basin soil loss reduction (tons) x basin delivery rate x ship channel trap efficiency = annual tonnage reduction of sediment deposited in the ship channel (one ton = 1.85 cubic yards).

A hypothetical example would be:

Given: a. Annual soil loss reduction of 1,000 tons
b. Delivery rate of approximately 10 percent
c. Ship channel trap efficiency of 32 percent

1,000 t/yr x 0.1 x 0.32 = 32 t/yr

32 t/yr x 1.85 cu yd/t = 59.2 cu/yd

[1] USDA, Soil Conservation Service, Universal Soil Loss Equation.

a. Hay

Hay is an environmentally friendly crop, but there are problems in increasing acreages of this crop. The problems are perception, market, and government programs. The perception is that hay is not a moneymaking crop and is too labor intensive to grow. There is no set price or local delivery locations as there are for corn and soybeans. Also, hay is not a commodity crop so there is no government subsidy.

One advantage is that each acre converted to hay reduces the same amount of erosion as two acres of crop residue management because of the superior erosion protection. To reduce 146,000 cubic yards of sediment in the harbor would require the conversion of 500,000 acres of cropland from corn and soybeans to hay. This is highly unlikely in the short term, but in the long term some additional acres could be converted. A look at the impacts of this crop and additional markets is recommended for long range study.

b. Small Grains - Wheat and Oats

1. Oats

While the demand for oat products remains high, most of the oats for human consumption are imported. There are no government subsidies for oats and the average price is around \$1.40 per bushel. With yields averaging 50 to 70 bushels per acre, gross returns are only \$70 to \$100 per acre. This barely covers the cost of land rental payments. No further action is recommended at this time.

2. Wheat

Wheat is a subsidized crop and acreage limitations are imposed yearly on this commodity crop. Significant increases in acreages are unlikely because those individuals who increase wheat acres more than their allotment would be ineligible for all government crop subsidies. Without these dollars being replaced from some other source, this is not going to happen. No further action is recommended at this time.

3. Alternative Crops

At least one alternative crop--canol--appears to have a chance at increasing acreage with additional assistance. Canola provides an excellent winter cover and would be beneficial to erosion reductions in the basin if included in the rotation. It is usually substituted for soybeans. Limitations are one of scale and market. The market infrastructure will not gear up to handle canola because it requires separate bins and management and the farmer will not raise it because there is no local market to deliver to and obtain the same pricing service that they get from corn and soybeans. It is recommended that this alternative crop be explored in the long range.

C. Nutrient, Livestock Waste, and Pest Management

These items are a concern to the overall water quality in the stream and Lake Erie; however, they have no direct bearing on the sediment deposition in the harbor and will not be addressed in this report.

2/22/93

Maumee Basin USLE Basin Erosion 1992 Base Year

	% in MAUMEE		CORN						SOYBEANS						WHEAT		
			CONVENTIONAL			CONSERV. -TILL			CONVENTIONAL			CONSERV. - TILL					
COUNTY	W.S.	BASIN	COUNTY	BASIN	USLE-TNS	COUNTY	BASIN	USLE-TNS	COUNTY	BASIN	USLE-TNS	COUNTY	BASIN	USLE-TNS	COUNTY	BASIN	USLE-TNS
ALLEN	1	1	59,207	59,207	232,684	10,007	10,007	15,111	59,624	59,624	234,322	17,929	17,929	27,073	27,677	27,677	15,776
AUGLAIZE	0.79	1	43,654	34,487	135,533	20,281	16,022	24,193	52,032	41,105	161,544	32,187	25,428	38,396	28,000	22,120	12,608
DEFIANCE	1	1	17,092	17,092	67,172	14,591	14,591	22,032	43,352	43,352	170,373	52,944	52,944	79,945	31,216	31,216	17,793
FULTON	1	1	42,676	42,676	167,717	45,400	45,400	68,554	42,222	42,222	165,932	49,486	49,486	74,724	16,344	16,344	9,316
HANCOCK	1	0.8	66,731	53,385	209,802	16,269	13,015	19,653	97,861	78,289	307,675	37,440	29,952	45,228	52,400	41,920	23,894
HARDIN	0.42	0.7	48,300	14,200	55,807	21,700	6,380	9,633	54,600	16,052	63,086	41,400	12,172	18,379	30,000	8,820	5,027
HENRY	1	1	44,257	44,257	173,930	34,773	34,773	52,507	54,056	54,056	212,440	40,780	40,780	61,578	36,128	36,128	20,593
LUCAS	1	0.8	17,548	14,038	55,171	12,162	9,730	14,692	27,799	22,239	87,400	19,459	15,567	23,506	8,382	6,706	3,822
MERCER	0.47	1	65,996	31,018	121,901	16,054	7,545	11,394	56,910	26,748	105,118	22,550	10,599	16,004	18,825	8,848	5,043
PAULDING	1	1	35,999	35,999	141,476	14,941	14,941	22,561	67,187	67,187	264,045	43,135	43,135	65,134	57,673	57,673	32,874
PUTNAM	1	1	67,533	67,533	265,405	13,390	13,390	20,219	82,669	82,669	324,889	32,601	32,601	49,228	51,560	51,560	29,389
VAN WERT	1	1	48,535	48,535	190,743	26,135	26,135	39,464	59,398	59,398	233,434	46,669	46,669	70,470	33,024	33,024	18,824
WILLIAMS	1	1	29,650	29,650	116,525	22,530	22,530	34,020	32,415	32,415	127,391	38,345	38,345	57,901	32,420	32,420	18,479
WOOD	1	0.25	58,400	14,600	57,378	39,600	9,900	14,949	81,200	20,300	79,779	54,800	13,700	20,687	45,000	11,250	6,412
SHELBY	0.06	1	30,000	1,800	7,074	25,000	1,500	2,265	43,420	2,605	10,238	29,580	1,775	2,680	20,000	1,200	684
HILLSDALE	0.53	1	53,900	28,567	112,268	51,100	27,083	40,895	19,000	10,070	39,575	26,000	13,780	20,808	12,000	6,630	3,625
LENAWEE	0.18	1	67,600	12,128	47,820	47,400	8,532	12,883	55,121	9,922	38,993	44,879	8,078	12,198	34,000	6,120	3,488
ADAMS	0.75	1	52,700	39,525	155,333	10,000	7,500	11,325	46,000	34,500	135,585	32,000	24,000	36,240	26,000	19,500	11,115
ALLEN	0.70	1	75,700	52,990	208,251	18,376	12,863	19,423	76,798	53,759	211,271	52,674	36,872	55,676	23,591	16,514	9,413
DEKALB	0.97	1	27,950	27,112	106,548	9,050	8,779	13,256	31,000	30,070	118,175	36,400	35,308	53,315	14,000	13,580	7,741
NOBLE	0.18	1	33,000	5,940	23,344	33,000	5,940	8,969	10,500	1,890	7,428	31,500	5,670	8,562	14,000	2,520	1,436
STUEBEN	0.20	1	8,360	1,672	6,571	33,440	6,688	10,099	2,210	442	1,737	19,898	3,980	6,009	7,800	1,560	889
WELLS	0.04	1	40,610	1,624	6,384	22,143	886	1,337	14,611	584	2,297	71,339	2,854	4,309	14,964	599	341
TOTAL			675,578	508,477	2,623,173	332,833	245,859	455,158	854,745	648,262	3,129,895	559,305	431,081	855,669	488,649	386,905	261,076

Toledo Harbor Sediment Reduction
Technical (TA) and Financial (FA) Assistance Needed

TYPE	YEARS ONE	TWO	THREE	FOUR	FIVE	SIX	7-15	16-20	TOTAL
Technical Assistance-$ SCS [1]									
3-Planners	105000	110250	115763	121551	127628	134010	0	0	714201
1-Engineer	46000	48300	50715	53251	55913	58709	0	0	312888
Overhead	22680	23814	25005	26255	27568	28946	0	0	154267
1-Administrator	42000	44100	46305	48620	51051	53604	0	0	285680
Overhead	6300	6615	6946	7293	7658	8041	0	0	42852
SWCD's Included in FA as needed									
Subtotal	221980	233079	244733	256970	269818	283309	0	0	1509889
Financial Assistance SWCDs									
A $.40 per cropland acre in basin - incentive payment	1322520	1322520	1322520	1322520	1322520	1322520	0	0	7935122
B $.35 per cropland acre - capitilization of maintenance fund	1157205	1157205	1157205	1157205	1157205	1157205	0	0	6943232
Local County Steering Committees (21*$1000)	21000	21000	21000	21000	21000	0	0	0	105000
Subtotal	2500726	2500726	2500726	2500726	2500726	2479726	0	0	14983355
Total	2722706	2733805	2745459	2757696	2770544	2763035	0	0	16493245

[1] Does not include three SCS Water Quality Coordinators presently in Ohio in the Maumee Basin.

APPENDIX D

S & L FERTILIZER (NU-SOIL)

Stan Pene

JONES & HENRY LABORATORIES, INC. / 2567 TRACY ROAD, NORTHWOOD, OHIO 43619 / (419) 666-0411

November 25, 1992

City of Toledo
Division of Water Reclamation
3900 N. Summit St.
Toledo, Ohio 43611
ATTN: Mr. R. Gerson

Dear Mr. Gerson:

Below are results of analysis of the sample received for examination on October 26, 1992:

Sample: TOLBVM Description: Nu-Soil
JHL I.D. AB28786 Client Project No. 78
Collected on: 10/26/92

TEST PARAMETER	UNITS	TEST RESULT	DETECTION LIMIT
TCLP NON-VOLATILE EXTRACTION		done	
Multicomponent analysis: TCLP METALS (MI)			
ARSENIC	mg/L	Not Det	0.04
BARIUM	mg/L	Not Det	4.0
CADMIUM	mg/L	Not Det	0.1
CHROMIUM	mg/L	Not Det	0.2
COPPER	mg/L	Not Det	0.2
LEAD	mg/L	Not Det	0.2
MERCURY	mg/L	Not Det	0.004
SELENIUM	mg/L	Not Det	0.04
SILVER	mg/L	Not Det	0.2
ZINC	mg/L	1.4	0.2
TCLP ZERO HEADSPACE EXTRACTION		done	
Multicomponent analysis: TCLP VOLATILES			
BENZENE	mg/L	Not Det	0.05
CARBON TETRACHLORIDE	mg/L	Not Det	0.05
CHLOROBENZENE	mg/L	Not Det	0.05
CHLOROFORM	mg/L	Not Det	0.05
1,4-DICHLOROBENZENE	mg/L	Not Det	0.05
1,2-DICHLOROETHANE	mg/L	Not Det	0.05
1,1-DICHLOROETHENE	mg/L	Not Det	0.05
METHYL ETHYL KETONE	mg/L	Not Det	0.05
TETRACHLOROETHENE	mg/L	Not Det	0.05
TRICHLOROETHENE	mg/L	Not Det	0.05
VINYL CHLORIDE	mg/L	Not Det	0.02
Multicomponent analysis: TCLP SEMIVOLATILES			
o-CRESOL	mg/L	Not Det	0.4

TCLP SEMIVOLATILES (continued):

m+p-CRESOL	mg/L	Not Det	0.4
PENTACHLOROPHENOL	mg/L	Not Det	0.4
2,4,5-TRICHLOROPHENOL	mg/L	Not Det	0.4
2,4,6-TRICHLOROPHENOL	mg/L	Not Det	0.4
2,4-DINITROTOLUENE	mg/L	Not Det	0.05
HEXACHLOROBENZENE	mg/L	Not Det	0.002
HEXACHLOROBUTADIENE	mg/L	Not Det	0.002
HEXACHLOROETHANE	mg/L	Not Det	0.002
NITROBENZENE	mg/L	Not Det	0.07
PYRIDINE	mg/L	Not Det	2.0
CHLORDANE	mg/L	Not Det	0.003
ENDRIN	mg/L	Not Det	0.001
HEPTACHLOR + HEPTACHLOR EPOXIDE	mg/L	Not Det	0.002
LINDANE	mg/L	Not Det	0.001
METHOXYCHLOR	mg/L	Not Det	0.003
TOXAPHENE	mg/L	Not Det	0.02

Multicomponent analysis: TCLP HERBICIDES

2,4-D	mg/L	Not Det	0.10
2,4,5-TP (SILVEX)	mg/L	Not Det	0.02

Multicomponent analysis: TCLP VOLATILES MATRIX SPIKE

BENZENE	% Recovery	97.2
CARBON TETRACHLORIDE	% Recovery	110
CHLOROBENZENE	% Recovery	93.1
CHLOROFORM	% Recovery	122
1,4-DICHLOROBENZENE	% Recovery	98.7
1,2-DICHLOROETHANE	% Recovery	95.2
1,1-DICHLOROETHENE	% Recovery	109
METHYL ETHYL KETONE	% Recovery	75.7
TETRACHLOROETHENE	% Recovery	98.6
TRICHLOROETHENE	% Recovery	103
VINYL CHLORIDE	% Recovery	100

Multicomponent analysis: TCLP SEMIVOLATILES MATRIX SPIKE

o-CRESOL	% Recovery	94.4
m+p-CRESOL	% Recovery	85.4
PENTACHLOROPHENOL	% Recovery	105
2,4,5-TRICHLOROPHENOL	% Recovery	73.4
2,4,6-TRICHLOROPHENOL	% Recovery	73.4
2,4-DINITROTOLUENE	% Recovery	116
HEXACHLOROBENZENE	% Recovery	42.2
HEXACHLOROBUTADIENE	% Recovery	49.8
HEXACHLOROETHANE	% Recovery	38.6
NITROBENZENE	% Recovery	105
PYRIDINE	% Recovery	124
CHLORDANE	% Recovery	103
ENDRIN	% Recovery	78.6
HEPTACHLOR + HEPTACHLOR EPOXIDE	% Recovery	88.5
LINDANE	% Recovery	77.3

TCLP SEMIVOLATILES MATRIX SPIKE (continued):

METHOXYCHLOR	% Recovery	107
TOXAPHENE	% Recovery	130

Multicomponent analysis: TCLP HERBICIDES MATRIX SPIKE

2,4-D	% Recovery	74.8
2,4,5-TP (SILVEX)	% Recovery	71.4

The above reported matrix spike recoveries verify method performance for all samples of this matrix type in this analytical batch. Metals were determined by standard addition and are automatically corrected for matrix spike recovery.

Please advise should you have questions concerning these data.

Respectfully submitted,

JONES & HENRY LABORATORIES, INC.

Fred W. Doering

Fred W. Doering
President

BROOKSIDE LABORATORIES, INC.
SOIL AUDIT AND INVENTORY REPORT

Name S & L Fertilizer City Whitehouse State OH

Independent Consultant Soil Tech. Inc. Date 12/04/92

Sample Location		NU-SOIL 11-92	11-92				
Sample Identification			SOIL				
Lab No.			SE29118				
Total Exchange Capacity (M.E./100 g)			84.90				
ph (H_2O 1:1)			7.30				
Organic Matter (humus) %			12.90				
Estimated Nitrogen Release		lb/A	127				
ANIONS	SOLUBLE SULFUR	p.p.m.	1060				
ANIONS	PHOSPHOROUS EASILY EXTRACTABLE	lb/A P as P_2O_5	673				
		p.p.m. of P	147				
	PHOSPHOROUS BRAY II	lb/A P as P_2O_5	826				
		p.p.m of P	180				
	PHOSPHOROUS OLSEN	lb/A P as P_2O_5					
		p.p.m of P					
EXCHANGEABLE CATIONS	CALCIUM:	lb/A	28562				
		p.p.m.	14281				
	MAGNESIUM:	lb/A	2224				
		p.p.m.	1112				
	POTASSIUM:	lb/A	370				
		p.p.m.	185				
	SODIUM:	lb/A	126				
		p.p.m.	63				
BASE SATURATION PERCENT							
	Calcium	%	84.10				
	Magnesium	%	10.91				
	Potassium	%	0.56				
	Sodium	%	0.32				
	Other Bases	%	4.10				
	Hydrogen	%	0.00				
EXTRACTABLE MINORS							
	Boron (p.p.m.)		1.24				
	Iron (p.p.m.)		405				
	Manganese (p.p.m.)		57				
	Copper (p.p.m.)		5.96				
	Zinc (p.p.m.)		106.60				
	Aluminum (p.p.m.)		533				
OTHER TESTS	Soluble Salts (mmhos/cm)						
	Chlorides (p.p.m.)						

mmhos/cm x 640 - p.p.m.

BROOKSIDE LABORATORIES, INC.
Environmental & Industrial Division
New Knoxville, Ohio 45871
(419) 753-2448
** ANALYSIS REPORT **

S & L Fertilizer
8636 Yawberg Road
Whitehouse, OH 43571

File Number: 60129
Date recv'd: 12/02/'
Date rept'd: 12/17/'

EID Rep: Soil Tech, Inc.
Attention: Stanley Perry

Lab Number Sample Description		SE29118 NU-SOIL 11-92 SOIL
ARSENIC	mg/kg	3.82
CADMIUM	mg/kg	3.50
CHROMIUM-TOTAL	mg/kg	138
LEAD	mg/kg	95.0
MERCURY	mg/kg	0.64 #
MOLYBDENUM	mg/kg	22.0
NICKEL	mg/kg	102
PCBs (TOTAL)	mg/kg	< 0.10 #
SELENIUM	mg/kg	0.06

Mercury & PCB's is on an as is basis, all other parameters are on dry.

Jeffrey P. Brachok

Jeffrey P. Brachok
Division Coordinator

APPENDIX E

OVERVIEW OF PAST STUDIES

SEDIMENT ANALYSES:

Aqua Tech Environmental Consultants, Inc., 1986. The Analyses of Sediments from the Proposed Open-lake Disposal Site at Toledo, OH, Technical Report No. G0176-17, October.

Samples were collected from SE side of channel. Data included sediment and bioassay data. Analyses included nutrients, metals, PCBs, PAHs, and pesticides.

TP Associates International, 1987. The Analyses of Sediments from the Proposed Open-lake Disposal Site at Toledo, OH, Technical Report No. I0175-06A, December.

Sediment were collected from the proposed disposal site, NW of the channel. Included sediment and bioassay data analyzed for nutrients, metals, PCB, PAH and pesticides.

"Analyses of Sediments from Toledo Confined Disposal Facility," Toledo, OH; Technical Report prepared for Richard Leonard, 30 October 1985

Two sediment samples from 240 acre CDF sand, silt T were collected. Additional soil samples were collected from Pen 7, silt and analyzed for metals, conventionals, pesticides, PCb's, and PAH's.

Aqua Tech Environmental Consultants, Inc., 1984. Analysis of Sediment from Toledo Dike Disposal Facility, Toledo, Ohio. Prepared for Mr. Richard Leonard, USAE Buffalo District, December.

Three soil samples from Grassy Island CDF and two soil samples from 240 acre CDF. Cores to 186" with incremental depth samples. Metals, conventionals (no oil and grease, COD), pesticides, PCB's, and PAH's.

TP Associates International, 1988. Analyses of Sediments from Toledo Harbor, Technical Report No. I0175-12, June.

Sediment data from R-7M to L-16M and aquatic disposal site D1. Metals, conventional parameters, pesticides, PCB's, and PAH's. Sediment bioassays with Hexagenia limbata, Daphnia magna, and Pimephales promelas.

Aqua Tech Environmental Consultants, Inc., 1985. Analyses of Sediment and Water Samples from Toledo Harbor, Toledo, OH; Technical Report for Mr. John Adams, USAE Buffalo District, August.

Three sediment samples from new CDF site. Four overflow weir samples. Metals, conventional parameters, pesticides, PCB's, PAH's on sediments. Metals, conventionals, PCB's, and PAH's on water samples.

Floyd Browne Associates, Ltd, 1984. Analysis of Sediment from Toledo Harbor - Maumee River, Toledo, OH; Technical Report #G0130-05, February.

Sediment samples from R7M to L7M. Sediment bioassays using H. limbata, P. promelas, and D. magna. Results showed L3M and R5M not polluted, L7M, L6M, L5M, L4M, L2M, L1M, OM, R3M, and R7M were moderately polluted, and R1M was heavily

polluted.

SAIC, 1989. Maumee Bay Bottom Characterization Study and Appendices, September/October 1988.

The study evaluated bottom sediment profiles using Seismic and Side-scan Sonar Surveys and REMOTS Sediment Profile Photography. Observations of bedforms indicated high bottom shear stress and active sediment transport as bedload throughout the area studied. Sediments in the vicinity of the open-water disposal site were re-worked by storms and wave action. Species able to survive bottom disturbances was observed to dominate the fauna at some stations.

Giesy, J.P. and Hoke, R.A., 1988. Toxicity of Sediment from Western Lake Erie and the Maumee River at Toledo, OH, 1987, Michigan State University, August.

Sediment bioassays on 78 river/lake samples, bioassays included Photobacterium phosphoreum (Microtox), Ceriodaphnia dubia, Chironomus tentans, and Pimephales promelas. Results showed no difference between L4M - L16M and the open-lake disposal site or reference site.

City of Toledo, 1986. "Sediment Re-classification, Toledo Harbor". City of Toledo, Ohio EPA, and TMACOG. October.

Compares bulk sediment analyses to EPA and Ontario sediment pollution classification. Conludes Toledo Harbor sediments do not qualify for open-lake disposal, open-lake dumping has negative impacts, and alternatives to open-lake dumping must be found.

OPEN WATER EVALUATIONS:

DePinto, Joseph, et al, 1986. Effect of Open-lake Disposal of Toledo Harbor Dredged Material on Bioavailable Phosphorus in Lake Erie Western Basin, Clarkson University, September.

Twelve sediment samples from the channel, within the open-lake disposal site, and open-lake reference site. Lab tests to model release of phosphorus during open-water disposal of sediments.

USACE, 1986(a). Evaluations of Open Lake Disposal Operations in Lake Erie - 1985, Buffalo.

Field monitoring of dredged material disposal at the open-lake disposal site. Water quality analyses for DO, clarity, phosphorus, and suspended solids.

USACE, 1986(b). Evaluations of Open Lake Disposal Operations in Lake Erie - 1986, Buffalo.

Field monitoring of dredged material disposal at the open-lake disposal site. Sampling conducted over entire disposal site, over the entire dredging season, but away from the dredge. Samples were analyzed for pH, turbidity, nutrients, and metals.

FWPCA, 1968. Lake Erie Environmental Summary 1963-1964. U.S. Dept. Interior., Federal Water Pollution Control Administration, Great Lakes Region. 170 pp.

Describes dominant surface and bottom current patterns in western Lake Erie.

Aqua Tech Environmental Consultants, Inc., 1986. Monitoring of Open-lake Disposal Program at Toledo Harbor - Toledo, OH - July 1986, August.

Results of field monitoring and laboratory analyses of water samples collected in June 86. The purpose was to study the effects of open lake disposal of Toledo Harbor dredged sediments on the water quality of Lake Erie. Analyses included DO, pH, conductivity, temperature, nutrients, and heavy metals.

BENEFICIAL USES:

Danneberger, Karl, PhD., 1985. Evaluation of Dredged Material for Golf Course and Parkland Construction Toledo, Ohio, November.

Toledo Harbor sediment needs nutrients and organic matter amendments to improve its properties for growing grass.

TMACOG, 1989. Evaluation of Woodtick Peninsula Restoration and Recreational Hill/Upland Disposal Alternatives, Addendum I, Preliminary Geotechnical Investigation of the Proposed Upland Disposal Site, Erie TWP., Monroe Co., Michigan, November.

Describes geology and geotechnical study for proposed area at Woodtick Peninsula Restoration and Recreational Hill/Upland disposal sites.

TMACOG, 1989. Evaluation of Woodtick Peninsula Restoration and Recreational Hill/Upland Disposal Alternatives using Toledo Harbor Dredge Spoil Material, Toledo-Lucas County Port Authority, July.

Approximately 6 million cu. yd. of dredged material could be used for this Woodtick Peninsula and 28 million cubic yards for the Recreational Hill.

TMACOG, 1990. Toledo Harbor Dredge Material, Beneficial Reuse Alternatives Status and Needs Report, May.

Describes quantities of soil material needed by landfills.

CONFINED DISPOSAL FACILITY EVALUATIONS:

Aqua Tech Environmental Consultants, Inc., 1986. The Analysis of Water Samples from the Toledo Confined Disposal Facility, Technical Report No. G0176-04, January.

Five water samples were collected in December 1985 from the CDF. Analysis included metals nutrients, SS, nutrients, metals, and organics.

Aqua Tech Environmental Consultants, Inc., 1986. The Analysis of Water Samples from the Toledo Confined Disposal Facility Overflow - Toledo, OH, Technical Report No. G0176-13, October.

Samples were collected in August 1986 from the overflow area of the CDF.

Aqua Tech Environmental Consultants, Inc., 1985. Column Leach Testing of Sediments from Toledo Dike Disposal Facility, Toledo, OH; Technical Report No. G0159-02-B, prepared for Richard Leonard, August.

Contains the results of the analyses of leachate water collected from columns on 8 sediment samples collected by the COE from the Dike Disposal Facility. Analyses included nutrients and metals.

USAE Buffalo District, 1990. Environmental Assessment and Section 404(b)(1) Evaluation, Dredging and Disposal of Dredged Material at Island 18 Confined Disposal Facility, Toledo Harbor, Lucas County, Ohio, Operation and Maintenance, November.

Evaluates the environmental impacts relative to Corps of Engineers dredging of the Toledo Harbor Federal Navigation Channel and resumption of use of the Island 18 CDF. Includes a finding of no significant impact.

USAE Buffalo District, 1990. Toledo Harbor, Ohio, Confined Disposal Facility, Final Impact Statement, June.

MITIGATION:

TCDP, 1990. Supplemental Letter Report on Mitigation Measures to Compensate for Fish and Wildlife Habitat Losses, Toledo, OH, December.

Describes various mitigation measures as compensation for the new CDF construction.

REMEDIAL ACTION PLAN:

OhioEPA, 1990. Maumee River Remedial Action Plan, Stage I Investigation Report, Ohio EPA, Maumee River Remedial Action Plan Advisory Committee, October.

Describes the pollution in Maumee River Watershed and Toledo Harbor.

TMACOG, 1991. Maumee River Basin Area Of Concern Remedial Action Plan, Volume 4: Recommendations for Implementation, Toledo, Ohio, 195 pp., July.

Describes recommendations for controlling pollution in the Maumee River AOC.

<u>OTHER REFERENCES OF INTREST:</u>

USAE Buffalo District, 1992. Dredged Material Management for Long-term Disposal Decisions, Toledo Harbor, Ohio: Work Plan, July.

Work plan for developing a Long-term Management Strategy for Toledo Harbor.

Public Notice: Operations and Maintenance, Toledo Harbor, Lucas County, OH; USAE Buffalo District, 22 February 1989

Public Notice for planned dredging in 1989. Includes quantity of material and proposed disposal site. Includes sediment data from 1988 in channel and from 1987 for disposal area.

Merry, Carolyn J., et al, 1988. Use of SPOT HRV Data in the Corps of Engineers Dredging Program, from *Photogrammetric Engineering and Remote Sensing*, Vol.54, No. 9, pp. 1295-1299, September.

Description of SPOT Satellite Remote Sensing Systems. System was tested on 4 June 86 during dredging operations to determine turbidity.

APPENDIX F

JULY 1992 WORK PLAN

DREDGED MATERIAL MANAGEMENT
FOR
LONG-TERM DISPOSAL DECISIONS

TOLEDO HARBOR, OHIO

WORK PLAN

U.S. Army Corps
of Engineers
Buffalo District

JULY 1992

TOLEDO HARBOR PLANNING GROUP
LONG-TERM DREDGED MATERIAL MANAGEMENT

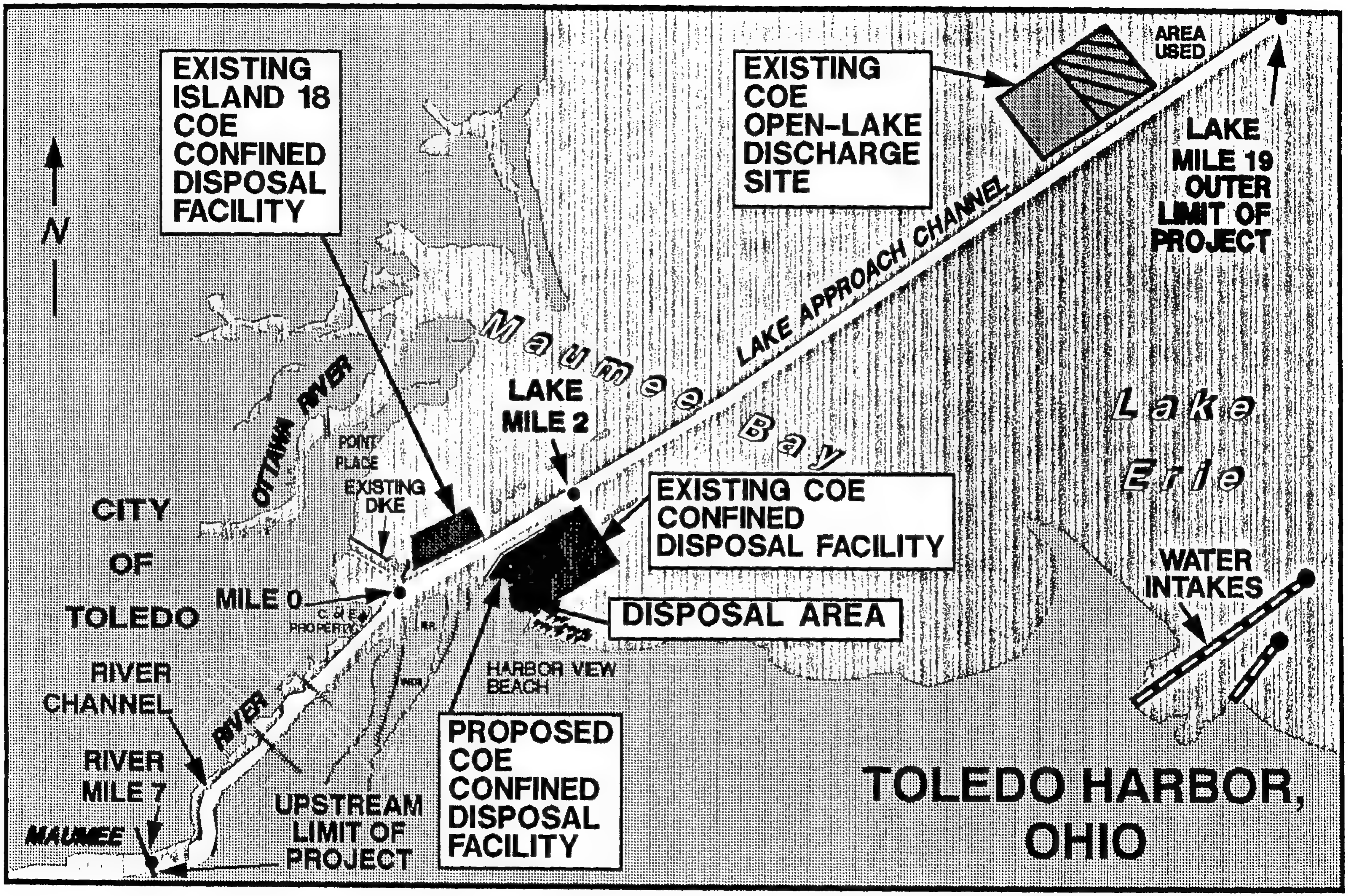
1776 Niagara Street Buffalo, NY, 14207

This Work Plan was developed by the Toledo Harbor Planning Group, an intergovernmental agency group created, at the directive of the Assistant Secretary of the Army for Civil Work (ASA-CW), to develop long-term dredged material management strategies for Toledo Harbor, Ohio.

The Plan was approved by ASA(CW) in August 1992 and executed by the Planning Group in September 1992.

On behalf of the Secretary, Ms. Nancy P. Dorn, I acknowledge and express appreciation to all agencies, their representatives, and representatives of the public involved in resolving this most difficult issue.

JOHN W. MORRIS
Colonel, U.S. Army
District Commander
Chairman, Planning Group



EXISTING ISLAND 18 COE CONFINED DISPOSAL FACILITY
EXISTING COE OPEN-LAKE DISCHARGE SITE
AREA USED
LAKE MILE 19 OUTER LIMIT OF PROJECT
N
LAKE APPROACH CHANNEL
Maumee Bay
Lake Erie
LAKE MILE 2
OTTAWA RIVER
POINT PLACE
EXISTING DIKE
CITY OF TOLEDO
MILE 0
C. of E. PROPERTY
EXISTING COE CONFINED DISPOSAL FACILITY
DISPOSAL AREA
WATER INTAKES
HARBOR VIEW BEACH
RIVER CHANNEL
RIVER
RIVER MILE 7
MAUMEE
UPSTREAM LIMIT OF PROJECT
PROPOSED COE CONFINED DISPOSAL FACILITY
TOLEDO HARBOR, OHIO

WORK PLAN - MEMORANDUM OF UNDERSTANDING
DREDGED MATERIAL MANAGEMENT FOR LONG-TERM DISPOSAL DECISIONS
TOLEDO HARBOR, OHIO

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DREDGED MATERIAL MANAGEMENT FOR LONG-TERM DISPOSAL DECISIONS
TOLEDO HARBOR, OHIO

U.S. Army Corps of Engineers	Ohio Environmental Protection Agency
U.S. Environmental Protection Agency	Ohio Department of Natural Resources
U.S. Fish and Wildlife Service	Michigan Dept. of Natural Resources
U.S. Soil Conservation Service	Toledo-Lucas County Port Authority
	City of Toledo

1 INTRODUCTION

These above Federal, State, local agencies and public representatives commit to achieve the specific goals and objectives stated below through the development of an Action Plan involving a range of coordinated activities including public information meetings and workshops which will be held during the study period. These specific goals and objectives are outlined as follows:

* Promote dredged material disposal management options that restore and/or enhance the environment, and have inherent acceptability and value to all partners of the Planning Group;

* Continue to keep Toledo's Port and Harbor open and safe for navigation; and

* Explore and promote productive use and/or reuse of dredged materials as a resource through an effective Public Involvement Program which increases citizens' awareness, interest and cooperation.

This agreement outlines the responsibilities agreed to by the U.S. Army Corps of Engineers; the U.S. Environmental Protection Agency, Region 5; the Ohio Environmental Protection Agency; the Ohio Department of Natural Resources; the Toledo-Lucas County Port Authority; the U.S Fish & Wildlife Service, the City of Toledo, the U.S. Soil Conservation Service, and the Michigan Department of Natural Resources with respect to the development of a Dredged Material Management Action Plan for long-term disposal decisions for the Toledo Harbor and navigation channels. Toledo Harbor is an authorized Federal Navigation project located in Toledo, Ohio. The existing project was authorized by the 1899, 1910,

1935, 1950, 1954, 1958, and 1960 River and Harbor Acts. As directed by the Office of the Assistant Secretary of the Army by letter dated 23 April 1992, and under this agreement, these agencies commit to work together as an interdisciplinary Planning Group (a team of various and independent experts) to produce the Work Plan described herein to guide the development of the dredged material management **Action Plan.** To facilitate the work of these experts, the Planning Group was structured as having an Executive Committee and a Study Team. (See attachments 1 & 2). The Planning Group will further the cause of environmental protection, restoration and/or enhancement through management of dredged material as a resource within the boundaries of the study area (as defined by the Planning Group).

This Work Plan with its companion Memorandum of Understanding constitute one document. It is the first document produced by the Planning Group with the concerted effort of all the participating agencies.

2 WORK PLAN

This Work Plan outlines the work to be accomplished and explains the critical path that will be followed by the Planning Group to achieve the specific results sought by the participating parties. An initiation meeting was held on 7 May 1992 followed by a 21 May 1992 meeting to ascertain membership, create the Executive Committee and the Study Team, identify and define the problem for which an acceptable solution is being sought, identify alternative management measures, develop a Memorandum of Understanding, and produce this Work Plan. The Work Plan with its companion Memorandum of Understanding contains the consented mode of operation that will guide the Planning Group in its deliberations and conduct of the studies leading to the development of the Action Plan.

3 ACTION PLAN

The required Action Plan will provide a **reconnaissance and/or preliminary feasibility** level of analysis for the considered alternatives. It will identify and recommend one or more alternative plans with potential to address the problem of managing dredged material disposal at Toledo Harbor. The recommended alternatives will be studied in detail in the implementation phase, and must be cost-effective, environmentally sound, complete and publically acceptable. Their development will be based on standard planning and engineering principles, including incremental analyses for cost-sharing purposes.

4 PROBLEM STATEMENT

Over the past several years, there have been a number of environmental concerns expressed by various agencies and individuals regarding the practice of open-lake disposal of dredged materials. Specifically, these concerns have been expressed regarding the negative impacts

of historic dredged material disposal methods on: Lake Erie water quality, particularly the Western Basin; City of Toledo water treatment plant; phosphorous level and algae bloom in the Lake; lake sediment chemistry; and use of near-shore areas.

The disposal of dredged material in the Western Basin of Lake Erie has become an ever increasing problem for which a mutually acceptable solution must be found. Because of the concerns over water quality, the environment, and the need to maintain, through on-going dredging, the operations of the Port of Toledo in an environmentally acceptable manner, the aforementioned agencies have agreed to work together to identify and develop mutually acceptable alternative solutions for long-term dredged material management decisions.

The Planning Group defines the problem within the context of providing continued operation and maintenance of the Port of Toledo with a view to achieving the goals of protection of water quality, environmental enhancement, safe and cost-effective navigation and protection of human health.

5 ALTERNATIVE MEASURES

There are a number of alternative measures and sub-measures identified by the Planning Group including those supported by the Secretary's Office. These measures and sub-measures will be analyzed and screened during the 16-month study period leading to the development of the dredged material management Action Plan for long-term disposal decisions in October 1993. Only the **principal structural and nonstructural alternative measures** are described below:

5.1 Structural/Nonstructural Measures

Productive Use and Reuse of Dredged Materials

Sediment Traps upstream of Navigation Project limit

Upland Erosion Control

Changes to Farm Techniques (Physical, Chemical)

Streambank Protection

Environmental Restoration (Woodtick Peninsula)

Open Water Disposal (Present and New Sites)

Confined Dike Disposal Facilities (In-water and Upland)

Use of Remote Confined Dike Disposal Facilities

Improving Regulatory Process

New water Quality Criteria and Compliance Rules

Sediment Load Reduction

Reduction of other point source discharges of pollutants

No-action

These management measures will be investigated, developed, analyzed, screened and assessed according to the first three phases of an accelerated five-phase planning approach (see enclosed Figure 1) for developing a long-term management strategy (Action Plan) for dredged materials.

Concerns and issues regarding the 1994 dredging plan were generally resolved by the Planning Group at the 21 May 1992 meeting. As a result, on 9 June 1992 the Buffalo District requested a 401 Water Quality Certification from Ohio EPA for the 1993 and 1994 dredging seasons. However, all concerns and issues regarding the management of the new CDF (7-10 years) must be resolved by the Planning Group; and recommendation(s) must reach the agency partners' offices and the Secretary's Office by October 1993.

6 STUDIES

The finding of mutually acceptable solution(s) to the problem described above may require several technical studies. The types of technical and other studies identified by the Planning Group are outlined below. Those agencies whose names appear in brackets next to the listed possible studies are agencies that have expressed a general commitment and interest in examining or contributing to the particular studies or parts thereof. These commitments will be further defined when the Scope of Work is clearly defined and made part of the Work Plan.

6.1 Institutional Studies

New Environmental Criteria for Dredged Material Evaluation (COE,US&OEPA)
Regulatory Process Improvement (All)
Policy and other Changes (All and RAP)
Public Involvement and Information (All)

6.2 Planning Studies

Review of Previous Studies (OEPA and RAP)
Cost Sharing (COE)
Cost Apportionment (COE)
Evaluation of Plans (COE, OEPA)
Evaluation of Open-lake Disposal Operations (COE, FWL, ODNR, OEPA)
Evaluation of Confined Disposal Facilities (COE)

6.3 Technical Studies

Plan Formulation (All)
Survey of New Disposal Sites (COE, TLCPA, ODNR, OEPA)
Environmental (COE, USEPA, OEPA)
Cost Engineering (COE)
Sediment Load Reduction (FWL, ODNR, OEPA)
Structural Design (COE)
Geotechnical (ODNR)
Coastal (COE, ODNR)
Hydraulic and Hydrology (COE, SCS)
Water Quality Evaluation (COE, US&OEPA, ODNR, FWL)
Economic (COE, TLCPA)

6.4 Field & Laboratory

Field Sampling of Dredged Material
Sediment Chemical Analysis
Phosphorous Load Concentration
Dredged Material Toxicity
Bioassay Testing
Sediment Settling Testing (COE)
River Bottom Characterization

Some of the above studies have been previously conducted to address some of these same issues listed in the previous problem statement paragraph in this Work Plan. Nevertheless, the results of these studies will be analyzed to reaffirm their conclusions or to recommend expansion of these or other studies, or to recommend additional studies. This will be done during the first phase of the aforementioned 5-phase planning approach. Each of the first three phases of the accelerated 5-phase planning approach must produce the expected results within the prescribed time period. The time period for executing the first three phases and a narrative description of each one of these three phases are presented in Table 1.

7 OVERALL SCHEDULE FOR DREDGED MATERIAL DISPOSAL MANAGEMENT

The overall schedule for developing a jointly supportable Action Plan for managing disposal of dredged materials from the Toledo Harbor commercial navigation channels is illustrated in Figure 2 herein enclosed. Figure 2 depicts the time frame (May 1992 through to October 1993) for the development of the Action Plan for long-term disposal decisions that the Planning Group will produce in October 1993. The work products that will result from this investigation are presented in Table 1 below along with the time-frame within which they must be accomplished.

Table 1 - STUDY SCHEDULE

Product	Milestone Date
Draft Work Plan and Memo. of Understanding	31 May 92
Final Work Plan and Memo. of Understanding	31 Jul 92
Dredged Material Disposal Agreement Plan for 1994	01 Jun - 31 Jul 92
Initiate Investigation	17 Jun 92
Public Information Meeting	17 Jun - 30 Sep 92
Report on 1st level of Assessment and Decisions	30 Oct 92
Management Measures Screened and Combined into Concept. Plans	16 Nov 92
Planning Evaluation of Conceptual Plans	30 Nov 92
In-Progress Review for Principals	30 Mar 93
Complete Investigation	01 Jun 93
Perform Evaluation, Develop & Pre-select Action Plan	02 Jun - 15 Jul 93
Initiate Draft Report	16 Jul 93
Prep. and Hold Public Meeting to Review Findings/Conclusions	16 Jul - 01 Aug 93
Complete Draft Report	30 Aug 93
Planning Group Review/Approval of Draft Report	01 Sep - 27 Sep 93
Revise and Finalize Report	28 Sep - 08 Oct 93
Reproduce Report	11 Oct - 21 Oct 93
Submit Final Report (LTMP)	22 Oct - 29 Oct 93

NOTE: Periodic Status Reports will be provided to the principal officials of the Planning Group's partner agencies.

7.1 First Phase. - This phase is intended to serve as the first level of assessment and screening and conclusion. An expanded flow-chart of steps that comprise Phase I is illustrated in Figure 1. The first phase should last 4 months (May 1992 - August 1992) during which all existing management options will be evaluated through analyses of existing data, previous study results, and other available appropriate field and laboratory studies to determine their preliminary feasibility, and potential impacts on the environment. This first phase has produced the Planning Group's jointly acceptable 1994 dredging plan and will possibly produce the jointly acceptable 1995-and-beyond management plan for the new confined disposal facility. Existing Corps Operation and Maintenance standards and other agencies' (U.S. Environmental Protection Agency, Ohio Environmental Protection Agency, U.S. Fish and Wildlife Service, and the City of Toledo) requirements will guide the development and execution of the plans.

Understanding and consensus reached in this or later phases will be documented by the Planning Group. A decision must be reached on the need to formulate and develop alternative management measures or to document the long-term practicality of the existing or currently proposed management options. The steps or essential activities that would lead to this level of decision making are described below.

The initial step is to identify and define the problem, develop the work plan, establish appropriate operational boundaries for the development of the Long-Term Management Action Plan (LTMP) and prepare a study cost estimate for existing and future work. Once the LTMP boundaries are set, the next step is to identify the dredging needs in terms of volumes, dredging frequency and dredged material characteristics for the project within the operational boundaries. Next, identification and assessment of existing disposal capacity should be made to allow for a comparison of needs versus existing capacities.

7.2 Second Phase. -- This phase should last three months from September 1992 through to November 1992. During this phase, all available management measures and options including structural and non-structural alternatives will be systematically screened and combined into alternative plans for detailed studies. Execution of this phase should produce viable long-term management options having the potential for meeting the Planning Group's established goals and objectives for the dredged material management plan for long-term disposal decisions. The essential activities of Phase II shown in Figure 1 are described below.

Compilation and analysis of existing data associated with the various management options will be performed to evaluate their feasibility. Necessary field and laboratory studies may be undertaken to define more precisely the actual impacts on the environment of the various disposal options. Inconclusive data will result in either no further evaluation of the management options or research and development. Once the validated data are available, viable management options will be combined into reasonably attainable alternatives. Preliminary cost information along with an environmental assessment will be developed to

guide the planning evaluation of alternatives, and subsequent elimination of alternatives that are not compatible with the Planning Group's established goals and objectives. The need for additional studies will be determined during the first phase of the study.

7.3 Third Phase. -- This phase would last eleven months (December 1992 - October 1993), and would provide a reconnaissance and/or preliminary feasibility level evaluation, screening, and selection of the preferred long-term dredged material management alternatives. A comparative assessment analysis that weighs and balances engineering, cost effectiveness, and environmental factors and benefits will be performed. Cost estimates, engineering studies, and environmental and economic analyses will be performed as necessary to aid in the planning process of formulating, evaluating, assessing, and selecting the best plan(s).

The result of this phase will produce an Action Plan presenting the most practicable Long-Term Management Plan(s) for implementation. The Planning Group will prepare the necessary documentation to support the selection(s), and forward the report to Secretary's Office for review and approval. All outstanding and/or unresolved issues during the first two phases must be resolved during this phase to insure joint support of the Action Plan by all partners, primarily the Planning Group.

It is recognized that due to limited time and resources available for the preparation of the Action Plan, additional studies and refinements may be recommended as part of the Action Plan's recommendation(s).

8 REMAINING TWO STUDY PHASES

After recommendation by the Planning Group and approval by the Secretary of the jointly supported dredged material management plan for long-term disposal decisions, the remaining two phases of the study, illustrated in Figure 1, should be executed within the context of the overall schedule shown in Figure 2. These two phases (Implementation and Monitoring Phases) are discussed below.

8.1 Fourth Phase - Implementation: During this phase, implementation of the Action Plan recommendations will commence with full considerations given to the administrative, procedural, management and monitoring requirements. The recommended alternative plans will be studied in detail based on standard planning principles, including incremental analysis, as appropriate.

Some operational considerations for implementation include:

* Environmental documentation for life of the plan
* Long-term water quality certifications

* Site specific permits/authorizations
* Mitigation strategies, as appropriate.
* Implementation of site management requirements

<u>8.2 Fifth Phase - Periodic Review and Update:</u> This final phase is a periodic reevaluation of the Long-Term Management Action Plan (LTMP), based on factors such as changing laws and regulations, local economy, environmental and physical conditions, and technological advances. An important aspect of this phase is to verify the validity of the assumptions made in the development of the Action Plan.

The intent of Phase V is also to assure that decision-making will maintain a viable implementation strategy which reflects changing times and project conditions, thereby avoiding the pitfalls of "crisis management." In the final analysis, the loop is closed allowing the dredging manager to anticipate and accommodate changes in dredged material management needs and to document the validity of the long-term technical, cost-effectiveness, and environmental management decisions.

9 CONDUCT OF BUSINESS BY THE PLANNING GROUP

The Planning Group and the Study Team will be guided, in their deliberation during the conduct of the study, by the mode of operation and understandings described in the WORK PLAN, and the Memorandum of Understanding (MOU) appended to the Work Plan. The MOU is an integral part of the Work Plan.

10 PUBLIC INVOLVEMENT

Throughout the study approach, the appropriate Federal, State, and local resource agencies and affected groups (ports, environmental organizations, and local citizens) will be fully involved in the process. The representative of Maumee River Remedial Action Plan (RAP) is the liaison between local groups and citizens and the Planning Group. The RAP coordinator will work with the Study Team, and as necessary participate in the process of formulating alternative plans. All available media (TV, Radio, Newspaper...) will be used to disseminate information about the alternative plans that will be considered in the process. At least two public meetings will be held, and workshops will be conducted as often as necessary to inform and educate the public on the Planning Group's effort in finding a long-term solution(s) for dredged material disposal at Toledo Harbor, Ohio.

11 INFORMATION MANAGEMENT

Information exchange between partner agencies, that is, the study team or their representatives will be channeled through the designated Study Team representatives to avoid gaps in the information chain. Avoidance of gaps in the dissemination of information is

essential to proper, timely and mutual agreement on the development of alternative plans. Mr. Wiener Cadet of the U.S. Army Corps of Engineers, and Mr. John Loftus of the Toledo-Lucas County Port Authority are the liaison between the Study Team and the Executive Committee.

12 REPORTING

The first report, that is, this Work Plan with the companion Memorandum of Understanding, will be forwarded to all the partner agencies and the Secretary's office on 31 May 1992, as required. Thereafter, and at the end of each phase, a progress report will be forwarded to all the partners and the Secretary's Office by the Planning Group to keep these agencies and the Secretary's Office apprised of the development of the study, and to specifically inform these Offices on the results of the phase.

The Action Plan for the long-term dredged material disposal decisions which must be supported by the partner agencies must be submitted to their offices and the Secretary's office at the end of October 1993.

13 CONCLUSION

To meet the environmental challenges facing management of dredged materials from Federal navigation channels at Toledo Harbor on Lake Erie, the Planning Group has put forth this Work Plan which commits the aforementioned multi-agency Planning Group to achieving broader goals of restoring and/or enhancing the environment, and keeping Toledo's Port open and safe for navigation by promoting productive use of dredged materials as a resource.

MEMORANDUM OF UNDERSTANDING
LONG-TERM DREDGED MATERIAL DISPOSAL MANAGEMENT ACTION PLAN
TOLEDO, OHIO

This Memorandum of Understanding outlines the responsibilities agreed to by the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S Fish and Wildlife Service, the U.S. Soil Conservation Service, the Toledo Lucas County Port Authority, the Ohio Department of Natural Resources, the Ohio Environmental Protection Agency, and the City of Toledo with respect to the preparation of an Action Plan for the dredging and disposal of dredged material for Toledo Harbor and navigation channels. The Toledo Harbor is an authorized Federal Commercial Navigation project located in Toledo, Ohio. As a result of a number of historical issues raised over the years regarding dredged material disposal impacts on the environment, the Office of the Assistant Secretary of the Army has directed the Buffalo District Commander to convene a Planning Group to prepare the aforementioned Action Plan. The above cited parties have agreed to work together to identify and develop alternative plan(s) for long-term dredged material management decisions. The basis for this agreement is contained in the Corps of Engineers authorities under the National Environmental Policy Act 33CFR 233, 40 CFR 1501.7 to determine the scope of issues and significant issues related to a proposed action, and 33 CFR 337.9 that authorizes the Corps to identify and develop dredged material disposal management strategies for long-term needs.

1 PRINCIPLES AND GOALS - The underlying principle of this Memorandum of Understanding (MOU) is the need to bring together an inter-governmental and interdisciplinary Planning Group to develop a long term dredged material management action plan to continue the maintenance of Toledo Harbor and provide protection of water quality in Lake Erie. This MOU sets forth the scheduled events and participation necessary to achieve the ultimate goals of all parties. It is the expressed goal of the partnership presented in this MOU to work cooperatively, and to combine resources to produce a jointly-supportable Action Plan. It is recognized that each of the parties to the agreement operates under certain legal and policy constraints. It is further recognized that:

1.1 Short-term disposal management agreements are in place for the 1992 and 1993 dredging seasons, and the Planning Group has reached agreement that a similar procedure be followed for 1994 harbor maintenance dredged material disposal.

1.2 Mid-to long-term disposal management will be handled to some unknown extent by the new Confined Disposal Facility (CDF) that will be in place for use by the 1995 dredging season.

1.3 It is the continuing goal of the Planning Group to dispose of dredged materials in an environmentally acceptable manner.

1.4 It is the goal of the Ohio Environmental Protection Agency to eliminate the open-lake disposal of phosphorous-laden dredged material from Toledo Harbor into the Western Basin of Lake Erie through the identification, development and utilization of long-term dredged material beneficial reuses or recycling.

1.5 Although Section 148 (Public Law 94-587 of the Water Resources Development Act of 1976) of US Code 33 U.S.C. 419a limits the use of Federally funded CDFs to only polluted dredged material as a means of minimizing disposal costs, the ASA(CW) has directed the Planning Group to investigate options for cost sharing of disposal costs consistent with the goals of the agencies involved.

1.6 All participating agencies acknowledge that this effort does not preclude any options from potential implementation; and that cost-sharing is recognized as a critical element in the implemention of recommended long-term management options.

2 PLANNING GROUP - The Planning Group is currently under the Chairmanship of the U.S. Army Corps Of Engineers. The partner agencies include the Corps of Engineers, the Toledo-Lucas County Port Authority, the Ohio Environmental Protection Agency, the U.S. Environmental Protection Agency, the Ohio Department of Natural Resources, the Michigan Department of Natural Resources, the U.S. Soil Conservation Service, the U.S. Fish and Wildlife Service, and the City of Toledo. The agencies will designate representatives and alternates (if they choose) to serve as voting members of the Planning Group.

The Planning Group may invite other agencies, consultants, and the public to participate in various aspects of the Action Plan development. The Planning Group will also seek input and provide feedback to the public as the study progresses using news releases and public information meetings and workshops as appropriate.
The members of the Executive Committee will designate one or more persons to serve on a Study Team. This Study Team will coordinate on all matters relating to execution of the study and compliance to cost estimates, schedules, conduct of tasks and recommendations to the Executive Committee for its approval.

3 OBLIGATIONS OF PARTIES - Planning Group members and their agencies each bring different backgrounds, perspectives, authorities and responsibilities to the association. Each member will determine the level of participation, in-kind services and contracts that their agency can bring to bear in the development of the Action Plan. These contributions will be coordinated into the overall study to maximize use of resources and development of the best product possible. Furthermore, the Planning Group's partner agencies activities are to be consistent with their individual activities.

4 OPERATING POLICY - Potential alternatives and combination of alternatives to manage dredged sediments will be evaluated by the Planning Group in a logical process utilizing objective criteria. The Planning Group will strive to operate via consensus of all members; however, situations may occur where consensus may not be possible. In those

cases the members will agree upon a plan of action to resolve the dispute and assign one or more members with the responsibility of investigating, documenting, and drafting a recommendation for resolution for the Executive Committee to consider. The members of the Executive Committee will agree upon what issues need to be resolved, identify the actions or studies needed to make a decision, and seek to provide the resources necessary to address the issue. Should the Executive Committee reach an impasse in resolving a particular issue, ASA(CW) will be contacted and brought in with a view to resolving the dispute. Every effort should be made by the Planning Group and ASA(CW) to resolve the issue one way or another.

The Executive Committee will meet at least quarterly, and on an as needed basis to provide prompt direction and decisions to the Study Team. The Planning Group members or their representatives will be present at public involvement activities.
Planning Group meetings will be open to the public with announcement of the meeting made in advance to facilitate interaction and awareness of the study, its goals and objectives, the outcomes of investigations undertaken, and recommended actions.

5 SCHEDULE AND EXECUTION OF STUDIES - This schedule is designed to set up a series of events and participation which is necessary to achieve the principles of this study and provide a control mechanism to insure continuous direction, review, interaction and timely decisions. This schedule requires the attention and commitment of all members of the Planning Group.

5.1. The Planning Group will develop and produce a Work Plan outlining all investigations it believes can be accomplished within the given time constraints and with available agencies' resources by end of July 1992.

5.2. The Planning Group will produce a jointly-supportable Action Plan for long-term dredged material management decisions and forward it to the ASA(CW) by 30 October 1993.

5.3. Implementation of the Action Plan by the parties will depend upon its recommendations, the authorities of the involved agencies and governments, and the funding available.

5.4. The execution of the Work Plan will be based on the accelerated 5-phase approach discussed in detail in the Work Plan document.

6 FINANCING - It is the intention of this MOU that the parties determine the extent of their participation and contributions to the development of the Action Plan, both in terms of participation in the Planning Group (Executive Committee/Study Team) and the provision/conduct of investigations that will contribute to the specific goals and objectives outlined in page 1 of the Work Plan.

7 RESERVATION OF RIGHTS - The Planning Group's partner agencies reserve the rights to exercise and enforce all authorities provided to them under Federal, State, and local laws. It is expressly understood that compliance with the Work Plan and its companion Memorandum of Understanding and the performance of activities contemplated thereby does not obviate the necessity for all parties to obtain any and all permits or other authorizations which are required for such activities by State or Federal law.

8 TERMINATION OR SUSPENSION - This Work Plan with its companion Memorandum of Understanding shall terminate at the completion of the Study Period (Phases 1 through 5). However, any partner agency, upon 30-day written notice, may terminate or suspend its membership in either the Executive Committee or the Study Team, or both.

IN WITNESS WHEREOF, the parties hereto have executed this Work Plan and companion Memorandum of Understanding as of the day and year first above written.

BY: ______________________
JOHN W. MORRIS
Colonel, Corps of Engineers
District Commander

BY: ______________________
VALDAS V. ADAMKUS
Regional Administrator
U.S. Environmental Protection Agency

BY: ______________________
KENT KROONEMEYER
Supervisor
U.S. Fish and Wildlife Service

BY: ______________________
JOSEPH E. BRANCO
State Conservationist
U.S. Department of Agriculture
Soil Conservation Service

BY: ______________________
DONALD R. SCHREGARDUS
Director
Ohio Environmental Protection Agency

BY: ______________________
FRANCES BUCHHOLZER
Director
Ohio Department of Natural Resources

BY: ______________________
GARY L. FAILOR
President
Toledo-Lucas County Port Authority

BY: ______________________
THOMAS HOOVER
City Manager
City of Toledo, Ohio

PLANNING GROUP
DREDGED MATERIAL DISPOSAL MANAGEMENT
TOLEDO HARBOR, OHIO

EXECUTIVE COMMITTEE

U.S. Army Corps of Engineers	- COL John W. Morris
Toledo-Lucas County Port Authority	- Gary L. Failor
U.S. Environmental Protection Agency	- Valdas V. Adamkus
Ohio Environmental Protection Agency	- Donald R. Schregardus
The City of Toledo	- Thomas Hoover
Ohio Department of Natural Resources	- Frances Buchholzer

Attachment 1

PLANNING GROUP
DREDGED MATERIAL DISPOSAL MANAGEMENT
TOLEDO HARBOR, OHIO
STUDY TEAM

U.S. Army Corps of Engineers - Wiener Cadet
Toledo-Lucas County Port Authority - John Loftus
U.S. Environmental Protection Agency - Holly Wirick
Ohio Environmental Protection Agency - Colleen Crook
The City of Toledo - Whit VanCott
Ohio Department of Natural Resources - John Rupert
U.S. Fish and Wildlife Service - Kent Kroonemeyer
U.S. Soil Conservation Service - Robert Burris
Remedial Action Plan Coordinator - Jeff Busch
Michigan Dept. of Natural Resources - Hal Harrington

Attachment 2

PLANNING GROUP
DREDGED MATERIAL DISPOSAL MANAGEMENT
TOLEDO HARBOR, OHIO

OVERALL SCHEDULE